THE EFFECT OF INTERIOR DESIGN IMPROVEMENTS ON THE QUALITY OF LEARNING FOR GRADUATE LEVEL MILITARY OFFICER STUDENTS

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

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B.S., United States Military Academy, 1978
M.S., University of Texas, Austin Texas, 1986

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1991

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This study determined the effect of interior design improvements on student perceptions about the physical learning environment for the United States Army Command and General Staff Officers' Course from August 1990 to June 1991. In December 1990, officers who had attended the same six courses in two adjacent classrooms were surveyed about their physical learning environment. One classroom was configured in a conventional manner; whereas, the second classroom was renovated in the spring of 1990. Renovation work included improvements to the classroom's acoustics, lighting, climate control system, and electrical circuitry. In February 1991, students attending a course in the renovated classroom were also surveyed. Previously, these students attended class in only conventional classrooms. Students perceived that the following aspects of the renovated classroom significantly enhanced their physical learning environment: lighting to read textbooks, acoustical separation among classroom staff groups, separate entrances to staff group areas, individual student desks, and electrical capacity. Moreover, students perceived several features of the renovated classroom as having made little or no improvement to their learning environment: chair comfort, location of the projection screen, location of the computer work station, and ease of use of tack boards on the renovated classroom's interior operable walls.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

THE EFFECT OF INTERIOR DESIGN IMPROVEMENTS ON THE QUALITY OF LEARNING FOR GRADUATE LEVEL MILITARY OFFICER STUDENTS by MAJ R. Douglas Maurer, USA, 197 pages.

This study determined the effect of interior design improvements on student perceptions about the physical learning environment for the United States Army Command and General Staff Officers' Course from August 1990 to June 1991. In December 1990, officers who had attended the same six courses in two adjacent classrooms were surveyed about their physical learning environment. One classroom was configured in a conventional manner; whereas, the second classroom was renovated in the spring of 1990. Renovation work included improvements to the classroom's acoustics, lighting, climate control system, and electrical circuitry.

In February 1991, students attending a course in the renovated classroom were also surveyed. Previously, these students attended class in only conventional classrooms.

Students perceived that the following aspects of the renovated classroom significantly enhanced their physical learning environment: lighting to read textbooks, acoustical separation among classroom staff groups, separate entrances to staff group areas, individual student desks, and electrical capacity. Moreover, students perceived several features of the renovated classroom as having made little or no improvement to their learning environment: chair comfort, location of the projection screen, location of the computer work station, and ease of use of tack boards on the renovated classroom's interior operable walls.

ACKNOWLEDGMENTS

I gratefully acknowledge the assistance of numerous individuals in my study.

At the start of my research, Ms. Jean Hecimovich, Chief, Interior Design, TRADOC Engineer, sent me information about TRADOC's standard 30-man classroom design. Later, Jean forwarded me a copy of TRADOC's initial study regarding the relationship between the quality of training environments and training success.

CPT(P) Jack Matthews, Fort Leavenworth Resident Office, Kansas City District, U.S. Army Corps of Engineers, arranged for me to borrow light and sound meters from his safety office. Moreover, Jack loaned me his office's sling cyclometer from October 1990 to March 1991.

On 2 October 1990, my former office mates in the College's Directorate of Academic Operations -- MAJ Pete Eliason, CPT(P) Greg Goodall, and CPT Dan McElhinney -- helped me empirically measure the sound transmitted through the interior partitions and operable walls of classrooms 21 and 23, respectively.

Majors Marc Girard and John Campbell assisted me with the validation of my survey. Marc further aided my

efforts by reviewing and critiquing my draft of the first three chapters.

MAJ Mike Harris, course author for A451: Logistics for Commanders, arranged for his instructors to administer my survey to their students the week of 11 February 1991.

My committee members -- LTC Charles J. Piraneo, Mr. David W. Kent, and Dr. Rebecca M. Campbell -- skillfully guided my efforts to design and execute this study. Their superb input contributed greatly to my work.

Finally, I thank my wife and daughter, Lou Ann and Molly, for totally supporting me these past ten months in my research and in my studies at the U.S. Army Command and General Staff Officers' Course. If not for their unwavering love and encouragement, I would not have succeeded.

DOUGLAS MAURER

MAY 1991

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INTRODUCTION

Impetus for the Study

In the spring of 1990, the United States Army Command and General Staff College renovated a conventional classroom in its 31-year-old academic building (Bell Hall). The renovated classroom was a prototype (model) for the future renovation of the remaining classrooms in Bell Hall. The model classroom was designed to correct various impediments to learning identified by the College's 1982 acoustical study[1] and 1984 master plan.[2]

This study was a logical follow-on to the model classroom construction. Its purpose was to validate the model classroom design. Specifically, I set out to answer the following research question:

Would the model classroom's interior design improvements enhance student perceptions about their physical learning environment?

In fall 1990 and winter 1991, I surveyed students about the physical learning environment in the model classroom and in an adjacent conventional classroom. These survey results indicated that students perceived the following interior design improvements as having significantly enhanced their physical learning environment: lighting to read textbooks, acoustical separation among classroom staff groups, separate entrances to staff group areas, individual student desks, and electrical capacity. In addition, student perceptions revealed that several model classroom features made little or no improvement to their learning environment: chair comfort, location of the projection screen, location of the computer work station, and ease of use of tack boards on the classroom's interior operable walls.

Summary of Command and General Staff Officers' Course

The U.S. Army Command and General Staff College (CGSC), Fort Leavenworth, Kansas, is the primary Army education center for its mid-career officers. Accredited as a master's degree granting institution since 1976, CGSC annually conducts the ten month Command and General Staff Officers' Course (CGSOC). Approximately 1200 mid-career officers from all U.S. military services attend each year. Additionally, about 100 international military officers annually attend CGSOC.[3]

In academic year 1990-1991, U.S. military CGSOC students varied in age from thirty to fifty years old; their average age was thirty-six years old. They possessed from seven to twenty-two years of active service as commissioned officers in the U.S. military; their average length of service was thirteen years. Over fifty-six percent of these officers already possessed a masters or higher degree.[4]

CGSOC exists to prepare military officers for duty as commanders and principal staff officers at division and higher level organizations. (A division is a combat organization which comprises from 10,000 to 17,000 personnel.) The course consists of 815 hours of graduate level study: 605 hours of a core or required curriculum and 210 elective hours.[5]

Summary of Staff Group Instruction at CGSOC

In the years immediately following World War II, approximately 300 students annually attended CGSOC. Their instruction consisted primarily of lectures given to the entire class. Students often were organized into smaller groups (8-10 people) for map exercises; however, these groups usually worked without an instructor. The emphasis of CGSOC course work was primarily on passive learning.[6]

In 1948, CGSOC organized students into twelve equal sections and began to emphasize student participation in

learning. Although the lecture method of instruction still predominated throughout the course, instructors facilitated a limited amount of student discussion within each of the twelve sections.[7]

In the mid 1950's, the College made a concerted effort to organize CGSOC sections into small work groups for instruction. To do so, instructors further divided each of the twelve sections into four staff groups of twelve to fourteen students per group.[8] This organization for instruction, termed staff group instruction, integrated small group dynamics, teaching methodology, and instructor subject matter expertise during staff group sessions.[9] Still, section level lectures remained the dominant method of instructing CGSOC students.[10]

In January 1959, CGSC opened the doors of a new academic building: Bell Hall. Each classroom in Bell Hall was large enough to hold one section of CGSOC students. Furthermore, these rooms contained heavy curtains which divided each classroom into quadrants to accommodate four staff groups. Nevertheless, section level lectures continued to comprise the majority of CGSOC instruction. The Army did not assign enough instructors to the College to support further increases in the amount of CGSOC instruction at the staff group level.[11]

Work in staff groups grew to fifty percent of the CGSOC instruction in 1974.[12] From 1975 to 1986, this percentage remained relatively constant. In 1987, the College made a major commitment to instruction at the staff group level; students were organized into staff groups for seventy-eight percent of their course instruction. In 1990, that figure was eighty percent.[13]

Summary of Facility Support for Staff Group Instruction

As the amount of staff group work increased in Bell Hall's classrooms, so too did the need for those classrooms to better accommodate the physical requirements for instruction in staff groups. An acoustical study performed in 1982 concluded that the physical characteristics of the Bell Hall classrooms severely detracted from the learning environment of staff groups:

> The classrooms lacked adequate sound absorption material on the ceiling and walls. Therefore, speech communication in the staff groups was difficult.
>
> The heavy curtains did not adequately isolate the staff groups. Students in one group were distracted by those of the other three groups.
>
> Background noise from air handling equipment and fluorescent light ballasts created an unsuitable environment for classroom instruction.[14]

In December 1984, the U.S. Army Engineer District, Kansas City followed up the acoustical study by preparing a College master plan. This plan noted the College's attempt to increasingly organize students into staff

groups for instruction. However, the plan concluded that the lack of adequate facilities prevented the College from fully implementing its goal to increase the number of instruction hours at the staff group level.[15]

Specifically, the master plan deemed three physical aspects of the classrooms as inadequate. First, the plan stated that the Bell Hall classrooms were originally designed as single open areas. As the College increasingly divided these open areas during instruction, it failed to correspondingly revise the heating, ventilating, and air conditioning (HVAC) systems which supported the classrooms. As a consequence, students experienced thermal discomfort in the staff group setting.[16]

Second, the master plan indicated a general dissatisfaction among the College faculty with the lack of flexibility of the classrooms, not only in their capability to accommodate different organizations for instruction, but also in the acoustical problems inherent with the classroom design.[17]

Finally, the plan determined that the classrooms lacked the electrical circuitry to support the electronic media which the College was increasingly using in CGSOC instruction.[18]

The master plan concluded that each classroom should be renovated to attain the following environmental

qualities in support of the College's continued division of classroom space into quadrants:

HVAC.
Improved air circulation.
Capability to adjust to a wide variety of loads.
Quiet operation of equipment.
Individual temperature controls in each quadrant.

Acoustics.
Sound absorbing walls.
Gypsum board ceilings.
Sealed wall penetrations.
Acoustically treated doors.

Lighting. Fifty to 100 footcandles.[19]

Space. The master plan cited U.S. Army Service Schools Design Guide 1110-3-106:[20]

Conference Classroom - Twenty-five to thirty-five net square feet of space per student.

Laboratory Classroom - Forty-five net square feet of space per student.

Seminar Classroom - Twenty net square feet of space per student.

The master plan also affirmed that the CGSOC classrooms should remain carpeted; the College had carpeted all CGSOC classrooms in the mid 1970's.[21]

Shortly after the publication of this master plan, the College acted on some of these recommendations. In 1985, the College replaced the heavy curtain dividers with accordion-fold partitions.[22] In 1986, a contractor renovated sixteen classrooms by installing drop ceilings which consisted of sound absorbing tiles. This contractor also mounted new fluorescent lights in these ceilings.[23]

In a separate procurement action, the College contracted to have acoustical panels fastened on the walls over the classroom windows. The College also procured vertical, cloth blinds for classroom windows.[24]

Despite these renovation efforts, HVAC and acoustical problems still existed in each of the CGSOC classrooms. Early in 1987, the College's Directorate of Academic Operations prepered a Department of Defense (DD) Form 1391, Military Construction Project Data, to justify a project to renovate Bell Hall, including the CGSOC classrooms. Among other things, this DD Form 1391 noted the following physical deficiencies in the CGSOC classrooms:

> Inadequate air distribution into each quadrant.
> The lack of chalkboard and tack board surfaces.
> An insufficient amount of surge protected electrical circuits with multiple outlet locations.
> The lack of computer data link connections.
> Inadequate window coverings.
> Inadequate light control for the staff group configuration.
> The lack of sufficient separation between staff group areas.
> Less space per student than the minimum required by the U.S. Army Service Schools Design Guide for a laboratory classroom.[25]

Accordingly, the project justification document proposed modernizing several aspects of the CGSOC classrooms. First, this document proposed an upgrade of the mechanical, electrical, and other utility systems which supported Bell Hall. Further, the modernization proposal included the installation of folding panel

interior classroom walls to serve as sound barriers between staff group quadrants. This proposal also advocated a system of electrical outlets and computer data connections spread throughout the classroom floors.[26]

The Bell Hall project justification document concluded that the College's ongoing initiatives in the areas of automation equipment and organization for instruction would be greatly hindered unless the CGSOC classrooms were renovated. Without sufficient power circuits, the College would not be able to incorporate into CGSOC instruction the planned increase in student use of personal computers. Moreover, the absence of floor mounted electrical outlets would prevent students from flexibly arranging classroom furniture coincident with this greater use of personal computers. Finally, without sufficient sound separation between staff group quadrants, students would not fully realize the benefits of their organization into staff groups for instruction: greater interaction and participation.[27]

Currently, the Bell Hall renovation project is programmed to begin following the construction of a new General Instruction Building for the College in the mid 1990's. However, the Bell Hall renovation is, as yet, unfunded. Hence, no design work has been accomplished for this renovation effort.[28]

Model Classroom

In 1988, the U.S. Army Training and Doctrine Command (TRADOC) contracted the architect-engineer firm of Peck, Peck, and Associates to produce a standard design for each of the various classroom facilities in use at TRADOC's education centers. One such facility was a 30-man classroom.[29]

In the fall of 1988, Craig Marlow, an architect from the office of the TRADOC Engineer, met with representatives from CGSC and from Fort Leavenworth's Directorate of Engineering and Housing (DEH). They discussed a project to adapt TRADOC's 30-man classroom design to existing conditions at Bell Hall for use in renovating one CGSOC classroom during fiscal year 1990. In other words, TRADOC's 30-man classroom design would serve as a guide to renovate a 64-man CGSOC classroom.[30]

On 9 March 1989, representatives from CGSC, the Fort Leavenworth DEH, the TRADOC Engineer, and the TRADOC Deputy Chief of Staff for Training conducted a Bell Hall test classroom workshop at the office of Peck, Peck, and Associates in Washington, D.C. Jean Hecimovich, Chief, Interior Design, TRADOC Engineer, provided Peck, Peck, and Associates the following design criteria for their use in developing sketches to modify TRADOC's standard 30-man classroom for construction as a CGSOC classroom in Bell Hall:

Facilitate the CGSOC learning experience.

Accommodate instruction in large groups: one instructor per sixty-four students.

Accommodate instruction in medium groups: one instructor per thirty-two students.

Accommodate instruction in staff groups: one instructor per sixteen students.

Provide acoustical and entrance privacy to each quadrant in the classroom.[31]

In addition, the workshop attendees accomplished the following:

Completed a project milestone schedule.

Developed a funding game plan.

Assigned responsibilities for the various project tasks.[32]

Rehearsed a briefing for the Commandant, CGSC.

Subsequently, the Commandant, CGSC, approved this project to renovate one CGSOC classroom in fiscal year 1990. Further, the Commandant directed that this classroom be the model for the future renovation of the remaining CGSOC classrooms.[33]

In the summer of 1989, the Commandant added the model classroom construction to the College's ongoing expansion project to accommodate an additional 256 CGSOC students in academic year 1990-1991. In turn, CGSC requested and received from the Department of the Army $2.2 million to execute the CGSOC expansion project; $450,000 of this total was programmed for constructing and outfitting the model classroom.[34]

Using Peck, Peck, and Associates' concept sketches, the Fort Leavenworth DEH prepared the detailed drawings

and contract specifications for the model classroom. The DEH design included operable acoustical interior walls which divided the classroom into quadrants. This design also detailed separate entrances to each of these quadrants. The model classroom design further included independently controlled heating and cooling in each quadrant, an acoustical tile ceiling, and indirect fluorescent lighting. Oak wood trim and a carpeted, raised computer floor comprised the remaining major design features.[35]

Scattered throughout this raised floor were forty flush-mounted, multi-purpose outlets: ten outlets per quadrant. Each outlet contained two duplex electrical receptacles, one telephone jack, and one computer connection which was linked to the College's local area network. Among the model classroom's space-saving features were ceiling-mounted projection screens, wall-mounted marker and tack boards, and tackable surfaces on the operable walls.[36]

Recessed in the model classroom's outer walls were cabinets for storing audiovisual equipment and classroom material. Each quadrant had one cabinet. Audiovisual equipment in each cabinet included a 26 inch multisync color television/monitor with two 2.5 inch speakers, a 35 mm slide projector, a 3/4 inch video cassette player, and a 1/2 inch video cassette player. In addition, one

overhead projector and projector cart outfitted each quadrant.[37]

Furniture for the model classroom included individual student desks, and shock absorbing office chairs on casters. Each quadrant also received one computer work station, complete with personal computer and printer.[38]

On 30 March 1990, the Fort Leavenworth Directorate of Contracting awarded the CGSOC expansion contract to TOL-TEC Construction, Kansas City, Missouri. This contract included the construction of the CGSOC model classroom. TOL-TEC Construction built the model classroom from 6 April 1990 to 31 July 1990.[39]

Fort Leavenworth Media Support Center personnel installed the cable which linked the model classroom's televisions/monitors to the College's educational television network. Fort Leavenworth's Directorate of Information Management procured and installed the cable and equipment for the model classroom's telephone jacks and computer data connections. The College's Directorate of Support Activities procured and outfitted the classroom with furniture and audiovisual equipment. CGSOC instruction began in the model classroom on 6 August 1990.[40]

Model Classroom Cost Summary:[41]

Construction -	$349.2K
Furniture and Equipment -	$ 59.6K
Total -	$408.8K

Objectives of the Study

As approved by the Commandant, CGSC, the CGSOC model classroom was a prototype for renovating the remaining CGSOC classrooms. Academic year 1990-1991 provided the first opportunity to evaluate this prototype. The primary objective of the study was to determine the effect of the model classroom's interior design improvements on student perceptions about the CGSOC physical learning environment. This evaluation provided College planners as well as the Fort Leavenworth DEH with a reference for designing the contract package to renovate the remaining classrooms in Bell Hall.

A secondary objective of the study was to provide input to TRADOC's ongoing initiative to determine the relationship between the physical environment for training and training effectiveness. In 1989, TRADOC commissioned a study to predict this relationship. Instead, this study yielded a recommended plan for continued study. The recommended research is much broader in scope than that which I conducted for the model classroom. Nevertheless, findings about the impact of interior design improvements

on student perceptions about the physical learning environment of the CGSOC model classroom -- a TRADOC facility -- were still relevant to TRADOC's overall objective.[42]

Assumptions

1. CGSC is committed in the long term to the organization of students into staff groups for the majority of CGSOC instruction.

2. Following construction of the General Instruction Building, CGSC will renovate the remaining CGSOC classrooms in Bell Hall to improve the physical learning environment in support of instruction at the staff group level.

Definition of Terms

1. DD - Department of Defense.

2. TRADOC - The United States Army Training and Doctrine Command.

3. DEH - The Directorate of Engineering and Housing.

4. CGSC - The United States Army Command and General Staff College.

5. The College - The United States Army Command and General Staff College.

6. CGSOC - The United States Army Command and General Staff Officers' Course.

7. CGSOC Section - Group of sixty-four students who were assigned to one classroom.

8. CGSOC Staff Group - A division of a CGSOC section. Normally, there were sixteen students in a staff group. Four staff groups made up one section.

9. CGSOC Model Classroom - Bell Hall Classroom 23.

10. Quadrant - One fourth of a Bell Hall classroom: the space which was devoted to the instruction of a CGSOC staff group.

11. Interior Design - Physical improvement of interior space.

12. Functional Requirements - Physical capabilities which a classroom had to possess in order to facilitate CGSOC student learning.

13. Fiscal Year - 1 October to 30 September.

14. Academic Year - The ten months when the College conducted the Command and General Staff Officers' Course: normally from August until June. The course was divided into three terms. For academic year 1990-1991, these terms occurred during the following dates:

Term I - 9 August 1990 to 20 December 1990.

Term II - 7 January 1991 to 15 March 1991.

Term III - 16 March 1991 to 7 June 1991.

15. Staff Group Instruction - A method of organizing CGSOC students for instruction which integrated small group dynamics, teaching methodology, and instructor subject matter expertise. Staff groups comprised from twelve to sixteen students.[43]

Limitations of the Study

1. To determine the effect of the model classroom's interior design improvements on student perceptions regarding the CGSOC physical learning environment, I compared student perceptions about the physical learning environment in the model classroom with those of the physical learning environment in a conventional classroom. This comparison yielded suggested improvements to the model classroom design. However, such improvements may not necessarily constitute the ideal CGSOC classroom. Instead, future designers still need to assess CGSOC functional requirements. Together with this study's findings, the designers' assessment of functional requirements should produce a design for a physical learning environment which best serves the needs of CGSOC.

2. Individual instructors may have affected the learning environment of the students whom I surveyed as much as or greater than did classroom interior design. Each of the four 16-person staff groups in the model classroom and in the adjacent conventional classroom had

its own set of instructors for the various courses taught in these rooms throughout the academic year. Accordingly, I could not isolate the effects of those instructors' methods and personalities from the effects of the model classroom's interior design improvements on student perceptions about the CGSOC physical learning environment.

3. Finally, other intervening variables may have affected student perceptions about the quality of their physical learning environment. Included among these variables were student aptitudes, student living environments, or physiological factors such as eyesight and hearing. Once again, I could not isolate the effects of these intervening variables from the impact of the model classroom interior design improvements on student perceptions about their physical learning environment.

Delimitations of the Study

1. I did not evaluate the cost effectiveness of the CGSOC model classroom construction.

2. I did not survey members of the College's staff and faculty about the model classroom design. Staff and faculty perceptions about this prototype classroom could be the focus of subsequent study.

3. The limited duration of this study prohibited conducting any surveys at the end of the academic year. For the students assigned to the model classroom, such a

year-end survey might have revealed changes in their perceptions about the model classroom's physical learning environment. Instead, students in section 23 were surveyed at the end of term I: a five month period in which they attended all their courses in the model classroom. During terms II and III, these students attended seven elective courses in the College's conventional classrooms as well as six required courses in the model classroom. Hence, subsequent studies which last the entire academic year could determine if section 23 students change their perceptions about the model classroom's physical learning environment between the end of term I and the end of term III.

Significance of the Study

A contract to renovate Bell Hall is not programmed for award until after the completion of the College's General Instruction Building in the mid 1990's. Hence, sufficient time existed to study the effect of the model classroom's interior design improvements on student perceptions about the CGSOC physical learning environment. Using the study results, College planners and the Fort Leavenworth DEH will be able to incorporate lessons-learned from the prototype classroom into the final design to renovate Bell Hall's classrooms.

The future Bell Hall renovation project will represent a major obligation of military construction funds, exceeding an estimated $7 million for the renovation of the 19 remaining CGSOC classrooms, alone.[44] Therefore, it made sense to evaluate the effect of the prototype classroom's interior design improvements on student perceptions about the CGSOC physical learning environment prior to developing and awarding a contract to renovate Bell Hall.

From August 1989 to July 1990, I was the College's project officer for the model classroom construction. Accordingly, I was familiar enough with the model classroom to research how this classroom's interior design improvements affected student perceptions about the CGSOC physical learning environment. In order to facilitate my research, the Class Director, CGSC, assigned me to this classroom as a CGSOC student in academic year 1990-1991 (Appendix I).

Additionally, this study furthered TRADOC's broader effort to determine the relationship between physical learning environment and learning effectiveness.[45]

ENDNOTES, CHAPTER 1

1
Directorate of Engineering and Housing, U.S. Army Garrison, Fort Leavenworth, "Bell Hall Acoustical Study" by George Butler Associates, Kansas City, Missouri, 26 March 1982, 9 - 10.

2
U.S. Army Engineer District, Kansas City, "Combined Arms University Master Plan" by Barrett, Daffin, and Carlan, Incorporated, Tallahassee, Florida, December 1984, 22.

3
Summarized from U.S. Department of the Army, United States Army Command and General Staff College Catalog, Academic Year 1990 - 1991 (Fort Leavenworth, Kansas: Government Printing Office, July 1990), i, 10, 36.

4
From a memorandum, subject: Class Demographics -- 90/91 Command and General Staff Officer Course, prepared by the Office of the Class Director, U.S. Army Command and General Staff College, 15 August 1990.

5
Summarized from United States Army Command and General Staff College Catalog, Academic Year 1990 - 1991, 36, 43, 54.

6
Summarized from Robert Doughty, "The Command and General Staff College in Transition, 1946 - 1976" (Fort Leavenworth, Kansas: U.S. Army Command and General Staff College, May 1976), 22 - 23.

7
Ibid., 23.

8
Ibid., 24.

9
From author interview Dr. Rebecca M. Campbell, Faculty Development Division, Directorate of Academic Operations, U.S. Army Command and General Staff College on 25 April 1991.

10
Robert Doughty, "The Command and General Staff College in Transition, 1946 - 1976", 24.

11 Ibid., 25.

12 Ibid., 27.

13 From CGSC Forms 951, "Course/Subcourse Data Cards", on file at the Schedules Branch, Office of the Registrar, Directorate of Academic Operations, U.S. Army Command and General Staff College.

14 Directorate of Engineering and Housing, U.S. Army Garrison, Fort Leavenworth, 9 - 10.

15 U.S. Army Engineer District, Kansas City, 22.

16 Ibid., 39.

17 Ibid., 48.

18 Ibid., 48.

19 Ibid., 59, 76, 77, 80, 82, 90.

20 U.S. Department of the Army, Design Guide 1110-3-106: Department of the Army Design Guide for U.S. Army Service Schools (Washington, D.C.: Government Printing Office, May 1986), 4-1, 4-18, 4-47. This design guide defines these classrooms as follows:

Conference classroom - For up to 200 students. One or more instructors conduct lectures, presentations, or demonstrations, (page 4-1).

Laboratory classroom - For instructor student ratios between 1:20 and 1:40. Primary use is for hands-on training on small equipment and lectures, (page 4-18).

Seminar classroom - Typically, fewer than twenty students. For small group discussions, briefings, or debriefings, (page 4-47).

21
From author interview with Mr. Steve Gomes on 21 September 1990 at Fort Leavenworth, Kansas. Mr. Gomes is a supervisor for Aquasis, Incorporated: the civilian contractor which provides classroom services in Bell Hall. He has worked at Bell Hall either as an enlisted man in the U.S. Army or as a civilian contractor employee ever since Bell Hall first opened in 1959.

22
Ibid.

23
From the project file: "16 Classroom Renovation, Building 111, Bell Hall", in the Plans and Operations Division, Directorate of Academic Operations, U.S. Army Command and General Staff College, 15 April 1986.

24
Ibid.

25
Summarized from the Department of Defense Form 1391, Military Construction Project Data, "General Instruction Building Modernization", on file in the Plans and Operations Division, Directorate of Academic Operations, U.S. Army Command and General Staff College, 31 March 1987. These military construction project data classified CGSOC classrooms as laboratory classrooms. Hence, these data listed space in CGSOC classrooms as a physical deficiency because they contained only thirty-nine net square feet per student. U.S. Department of the Army, Design Guide 1110-3-106: Department of the Army Design Guide for U.S. Army Service Schools, 4-18, specifies a laboratory classroom requirement of forty-five net square feet per student.

26
Department of Defense Form 1391, Military Construction Project Data, "General Instruction Building Modernization".

27
Ibid.

28
From author interview with Lieutenant Colonel Charles J. Piraneo, Chief, Plans and Operations Division, Directorate of Academic Operations, U.S. Army Command and General Staff College on 31 October 1990.

29
From the project file: "Model Classroom, Building 111, Bell Hall", in the Plans and Operations Division, Directorate of Academic Operations, U.S. Army Command and General Staff College, July 1990.

30
Ibid. Craig Marlow and Fort Leavenworth representatives at the fall 1988 meeting felt that a modification of TRADOC's standard design for a 30-man classroom would best meet CGSOC's functional requirements, even though requirements for a laboratory classroom were cited in Department of Defense Form 1391, Military Construction Project Data, "General Instruction Building Modernization".

31
From author telephone interview with Ms. Jean Hecimovich, Chief, Interior Design, TRADOC Engineer on 27 August 1990.

32
Summarized from the project file: "Model Classroom, Building 111, Bell Hall".

33
Ibid.

34
Ibid.

35
Directorate of Contracting, United States Army Garrison, Fort Leavenworth, "Contract DABT 1990 C 0015: CGSC Ramp-Up" (Fort Leavenworth, Kansas: U.S. Army Combined Arms Center, 30 March 1990), drawings.

36
Ibid.

37
Summarized from the project file: "Model Classroom, Building 111, Bell Hall".

38
Ibid.

39
Directorate of Contracting, United States Army Garrison, Fort Leavenworth, "Contract DABT 1990 C 0015: CGSC Ramp-Up", drawings.

40
Summarized from the project file: "Model Classroom, Building 111, Bell Hall".

41
Ibid.

42
Summarized from U.S. Army Training and Doctrine Command, "Improved Learning By Design: A Review of Research Findings and a Recommended Action Program" by John Seiler, Carol Burns, Jonathan Lane, and Daniel Schodek of the Harvard University Graduate School of Design, Cambridge, Massachusetts, February 1989, 3, 6.

43
Dr. Rebecca M. Campbell.

44
Estimated by multiplying the approximate cost of the model classroom by the number of CGSOC classrooms that remain to be renovated: ($400,000.00 X 19).

45
U.S. Army Training and Doctrine Command, 3, 6.

CHAPTER 2

LITERATURE REVIEW

Scope of Review

My literature review consisted of four phases. First, I sought information about evaluating the model classroom's interior design: the planned improvements to the CGSOC physical learning environment. Next, I researched the nature of CGSOC students' perceptions about their physical learning environment, both in the model and conventional classrooms. In turn, I reviewed numerous studies performed to accomplish objectives similar to those of my study. Including the recent TRADOC effort which related training environments to training success, I discovered twelve studies which evaluated in one manner or another the effect of interior design on the quality of physical learning or working environments. Moreover, I read how four educators advocated designing classrooms to enhance the physical learning environment. Finally, I researched what various social scientists had to say about

the design and execution of my survey to collect student perceptions about their physical learning environment.

Interior Design

1. Dahnke, Jones, Mason, and Romney - By constructing, then using a designed facility, planners can revise, refine, and update the facility's design for future use. Facility planning and design is a continuous process.[1]

2. Ching - The interior design process is not complete until we perform a critical appraisal of the constructed design. In other words, we must evaluate the design solution for its effectiveness in satisfying the user's needs. Through this evaluation, we gain lessons-learned for our use in future design efforts. We may judge an interior design using one or more criteria:

Does the design work?
Is the design affordable?
Does the design look good?
Is the design in fashion?[2]
Does the design carry meaning?

3. U.S. Army Service Schools Design Guide - This guide details the following general design considerations for classrooms:

Emphasize flexibility and provide ease of expansion.
Easily convert the classroom to other uses.
Minimize the disruption of activities during this conversion.
Provide movable partitions in spaces where changes in function or class size occur relatively frequently.

Separately control lighting for each 750 square feet of space.

Adjust lighting for various classroom activities: from thirty footcandles during audiovisual presentations to a maximum of seventy footcandles for classroom activities. Required lighting level for reading is fifty footcandles.

Separately control the temperature in each 750 square feet of space.

Background noise of thirty-five decibels produces optimum alertness for learning.

Light quality is more important than light quantity. Minimize glare and reflections in the classroom. Eliminate eye stress created by lateral differences in illumination. For example, light which streams in through windows may cause one side of the student's field of vision to be significantly brighter than the other side.

Temperature is the most important element of the classroom thermal environment. Maintain sixty-eight degrees Fahrenheit during the heating season and seventy-eight degrees Fahrenheit during the cooling season.

Relative humidity has little influence on student comfort provided that it remains between thirty percent and seventy percent. Relative humidities higher than seventy percent may impair student performance. Readings below thirty percent may cause students respiratory discomfort.

Recommended seating for instruction in staff groups is upholstered chairs on casters.

Provide a minimum of twenty square feet of space per student for instruction in staff groups.[3]

Forming Perceptions about Physical Environments

1. E.C. Relph - He defined place as an experience.[4]

2. Tuan - He contended that people develop their perceptions about places through personal experience. The intensity and quality of these personal experiences have a greater impact on people's perceptions about places than do the simple durations of these experiences.[5]

Relationship of Interior Design to Learning or Working Environments

1. Seiler, Burns, Lane, and Schodek - The purpose of their study was to identify the existence of a quantifiable relationship between the quality of training environments and the success of training throughout TRADOC. Training success was to be measured by skill retention, drop out rate, or other measures. Their literature review revealed a definite relationship between the physical classroom environment and learning behavior. However, they were unable to predict the extent of the relationship between TRADOC's physical training environment -- which extended beyond classrooms -- and the effectiveness of training conducted within these environments. Instead, they outlined an eight-step research implementation program to predict this relationship.[6]

The study group addressed three questions in response to TRADOC's interest in the relationship between training environment and training success:[7]

> Will improvements to the physical quality of TRADOC's classroom and training environments improve learning effectiveness?
>
> Is improvement in training environments cost effective in terms of TRADOC's mission?
>
> What level of confidence can be associated with any findings for the first two questions?

As it turned out, the study group explored the answerability of these questions, rather than providing

responses, because of research limitations. Several factors limited the study group's research. First, the scope of their problem was much too broad to be adequately solved within the study's funding ceiling. As a result, the group briefly visited two of TRADOC's twenty military installations. (TRADOC also operates seven additional schools at locations other than these twenty installations.) Thus, the group observed only a small portion of TRADOC's training activities.[8]

Next, the study group's literature review revealed that related research findings only partially applied to TRADOC's problem. Previous research examined the relationship between physical environments and learning in classroom settings. Instead, TRADOC's training settings encompassed more than just classrooms. TRADOC also conducted training in field conditions and in workshop settings to effect practical, hands-on exercises.[9]

Finally, the study group identified four intervening variables which they expected would distort the relationship between TRADOC's physical environments and training success as measured by skill retention and dropout rate. First, the hands-on, practical exercises which TRADOC conducted outside the classrooms also affected skill retention. Hence, the study group could not separate the skills which students gained in the classroom from those that they gained during the practical

exercises. Next, the study group noted that skills which soldiers performed during subsequent troop unit assignments may impact skill retention even more than the training environment at TRADOC's installations and schools. Furthermore, the quality of instruction as well as the aptitudes of TRADOC's students may also affect the success of classroom training. Lastly, the study group felt that the living and interpersonal environments of soldiers training on TRADOC posts may have an equal or greater impact on skill retention and drop-out rate than the quality of the classroom environment.[10]

Based on their literature review, the study group made the following conclusions about the relationship of physical environments to learning:[11]

> Current research regarding the effect of environment on learning focused on the overall quality of the learning environment, rather than on isolated variables within this environment. Although significant data existed to demonstrate that physical improvements positively impacted learning effectiveness, little data were available to calibrate the degree of individual improvements with the degree of improved learning.

The study concluded by recommending what the group termed a "difficult, time-consuming, and costly" research plan to:[12]

> clarify relationships between training effectiveness and the quality of the physical environment...
>
> ...and recommend a related cost-effective improvement program for TRADOC facilities.

2. Herzberg, Mausner, and Snyderman - Their study of job motivation revealed insights to the nature and method of operation of job attitudes. The central question of their study was "What do people want from their jobs?" They determined factors which made people happy about their jobs. They called these factors satisfiers. On the other hand, they also identified a different set of factors which made people unhappy about their jobs. These factors they termed dissatisfiers.[13]

They theorized that satisfiers only affected job attitudes in a positive direction. As a result, the presence of these factors tended to increase a person's job satisfaction. In contrast, the absence of these satisfiers did not necessarily contribute to job dissatisfaction.[14]

In like manner, dissatisfiers only affected job attitudes in a negative direction. The existence of dissatisfiers tended to create unhappy employees. However, the mere absence of dissatisfiers did not ensure happy employees. Specifically, dissatisfiers were factors of hygiene: those which operated to remove health hazards from the work environment. Among these factors of hygiene they included physical working conditions. Hence, improvements in the physical work environment merely served to remove impediments to positive job attitudes. However, whenever physical conditions deteriorated to a

level below that which an employee considered acceptable, job dissatisfaction ensued.[15]

3. Torbert - He studied the physiological factors that affected the nature of adult learners in the Phoenix [sic] Air National Guard. He concluded that the Air National Guard could improve their learning climate by better insulating classrooms against noise, increasing classroom lighting, and improving the air conditioning capability for the classrooms.[16]

4. Knowles - He advocated the findings of ecological psychologists regarding the effects of physical environment on learning. To avoid blocks to learning, the physical environment requires provisions for animal comforts such as temperature, ventilation, easy access to refreshments and rest rooms, comfortable chairs, adequate light, and good acoustics.[17]

Additionally, more subtle physical features may impact learning even more than provisions for animal comforts. For example, color directly influences the mood of adult learners. Bright colors induce cheerful, optimistic moods. Dark, dull colors induce opposite moods.[18]

Furthermore, Knowles noted that ecological psychologists suggest that the size and layout of physical space affect the quality of learning. Finally, Knowles stated that the richness and accessibility of material and

human resources are crucial to effective learning. Material and human resources comprise books, manuals, films, slides, tapes, and other audiovisual aids and devices. These resources also include educational media such as television and computers.[19]

5. Kurpius - He contended that facilities and services play a major role in fulfilling the needs of the adult learner.[20]

6. Slater - She tested seventh grade public school children in quiet, average, and noisy classroom environments to determine the effect of noise on performance. She defined noise as undesirable sound. Further, she used the following intermittent noise levels in her study to imitate the same noise which school children encountered in the classroom:

Quiet - Forty-five to fifty-five decibels.

Average - Fifty-five to seventy decibels.

Noisy - Seventy-five to ninety decibels.[21]

Student results on written tasks of relatively short duration revealed no trend in the effect of noise on performance.[22]

7. Brown and Wong - They studied the effects of the setting or arrangement of a work area on worker efficiency. They tested four groups of elementary psychology college students in two rooms. One room was orderly and pleasing: well-lighted, carpeted, and well

furnished. The second room was cluttered and displeasing: poorly lighted, filled with cases of old bottles and lumber scraps, and furnished with old, worn furniture. Two groups (six students per group) performed a multiple choice practical exercise in the orderly room. The other two groups performed the same exercise in the disorderly room. There was no significant difference among intelligence levels of the students in the four groups.[23]

Students in the orderly room solved more problems than did those in the disorderly room. Similarly, orderly room students took less time trials to solve each problem. Hence, they concluded that the effect of working in the cluttered room was to materially reduce the number of problems solved as well as the quality of the work solutions.[24]

8. Maslow and Mintz - They researched the short term effects on people of three visual-esthetic conditions: beautiful, average, and ugly rooms. They tested subjects in one of three rooms.[25]

The ugly room was the smallest of the three. It was dirty and messy, resembling a janitor's store room. Moreover, this room was furnished with two straight back chairs and a small table. The room was lighted by an overhead incandescent bulb. Further, the room had battleship gray walls.[26]

The average room was a professor's office: the largest of the three rooms. It too had battleship grey walls, but was lighted by an indirect overhead fixture. The average room was furnished with two mahogany desks, two straight back chairs, a metal bookcase, a metal filing cabinet, and a cot with a green bed spread. These furnishings gave the impression of a neat, clean, "worked-in" office.[27]

Finally, the beautiful room was well furnished to portray an attractive, comfortable study. Indirect overhead lighting and beige walls helped to create this portrayal. Furniture included a soft armchair, a mahogany desk, two straight back chairs, a large rug, a wooden bookcase, wall paintings, window drapes, and table art.[28]

Subjects spent approximately five minutes in one of the three rooms prior to the researchers administering the test. Testing lasted about ten minutes. The test was a measure of the subjects' impressions of the degree of energy and well-being in negative print photos of ten faces. Testing was accomplished at night when the building was quiet. Rooms were well lighted, despite the fact that lighting in the ugly room was harsh in comparison to the other two rooms. Subjects sat in identical chairs in each room. The windows in each of the rooms were open.[29]

The subjects in the beautiful room gave significantly higher ratings of energy and well-being to the faces in the test than did the subjects in either of the other two rooms. The mean test scores of subjects in the beautiful room fell in the range of energy and well-being; whereas, subjects' scores in the average and ugly rooms fell in the fatigued and displeased range.[30]

The researchers concluded that no single visual-esthetic quality accounted for the differences in the test scores. Instead, all aspects of the visual-esthetic conditions of each room worked together to produce the differences in the subjects' test scores.[31]

9. Ne'eman, Sweitzer, and Vine - They asked workers in a St. Louis office building to evaluate the levels of importance and satisfaction associated with environmental conditions in work spaces.[32]

The office workers rated the following features of the work environment as the most important:

Proper amount of space.

Ability to control summer temperatures.

Capacity for private phone conversations.[33]

Furthermore, the workers ranked the following environmental features among the most important:

Ability to have private office conversations.

Correct amount of light for reading.

Control of summer and winter ventilation.[34]

Among the least important environmental working conditions rated by the workers were:

Window views.

Control of noise outside the building.

Privacy of the work area.

Control of window drapes.

Access to light controls.[35]

The researchers noted that because work space conditions are complex and interrelated, their questionnaire may not have included all conditions which affected worker responses. Additionally, their questionnaire results lead them to believe that attempts to improve one work space condition may improve other conditions.[36]

The researchers used their questionnaire results to categorize work space features into the following groups:

Thermal conditions.

Lighting controls.

Sound controls.

Shading devices.[37]

Finally, they concluded that the workers' evaluations of the work space features were affected by the respondents' locations in the building (floor and proximity to the exterior), the work space plan, the window orientation, the amount of time spent at the work place, and the age and gender of the respondents.[38]

10. Montagne and Wollin - They researched the effect of physical environment on learning. They hypothesized that an amiable classroom environment would beneficially affect human performance and interaction. They further proposed that these beneficial effects would be evident in the following human performance:

Improved learning.

Positive evaluations of the teacher.

Greater student-teacher interaction.

Positive attitudes about the amiable classroom.

Minimal vandalism.[39]

The subjects for the study comprised two classes of an undergraduate introductory psychology course. The independent variable was the classroom environment. The researchers chose two identical, adjacent classrooms for their study. The interior of the experimental room was changed in accordance with a design consultant's guidance. As judged by this consultant, the experimental room was complex, warm, and congenial. In contrast, the consultant judged the control room as sterile, cool, unyielding, and austere. Overall, the consultant judged both rooms aesthetically pleasing for their interior design style; however, he rated them radically different in their ambience.[40]

One psychology class spent half of the academic quarter in the experimental room; the other class spent

this time in the control room. Then, the classes changed rooms for the remainder of the academic quarter. The researchers measured five dependent variables during the quarter. First, they assessed student learning by the performance on an exam administered after the first five weeks of the academic quarter and on an exam administered five weeks after students had changed rooms. Next, students completed a written teacher evaluation at mid-quarter and again at the end of the quarter. The researchers measured the students' perceptions of both rooms through a written questionnaire. Finally, researchers checked each room weekly for signs of vandalism.[41]

Students scored a higher percentage of correct answers on the exams administered in the experimental room than on the exams administered in the control room. Moreover, students evaluated their teacher significantly more positively when in the experimental room than when in the control room. The number of observed student-teacher interactions were not significantly different between the two classrooms. Students perceived the experimental room as significantly more interesting, pleasant, and comfortable than the control room. Further, students did not perceive the experimental room as more distracting than the control room. Finally, no vandalism occurred in either classroom during the study.[42]

Consequently, the researchers made the following conclusions:

Physical classroom environment can affect the amount of learning as measured by scores on tests.

Physical classroom environment can have a strong effect on the quality of student-teacher interaction.

Students appreciate well furnished classrooms. Such classrooms do not detract from the student learning process. Neither do they inhibit student concentration.

Public buildings need not be barren and indestructible to be safe. Instead, people deserve a warm and attractive environment and will respect such places.

In general, improving the interior of college classrooms can have a beneficial effect on the activity therein.[43]

11. General Services Administration (GSA) - The GSA tested the influence of air conditioning on work production. The test site was a government office building in the continental United States. The test period was from May to September 1957. The GSA established two areas: a test area and a control area. Employees in both areas performed identical work -- file searches -- under similar work conditions, with one exception. The test area was air conditioned to maintain a uniform temperature of seventy-five degrees Fahrenheit

(plus or minus two degrees) and a relative humidity of fifty percent or less. The control area was not air conditioned. Employees used large fans in this area for air circulation and cooling during the spring and summer months.[44]

During the test, the GSA measured the number of file searches completed daily by employees in both areas. Additionally, the GSA measured the number of file search errors committed per person in each area. Finally, the GSA monitored employee absenteeism in each area.[45]

The GSA measurements indicated that the work production of the employees in the test area exceeded that of the employees in the control area by an average of 9.5 percent. Further, the number of file search errors per person was .9 percent lower among test area employees than among control area employees. Lastly, absenteeism of the workers in the test area was 2.5 percent lower than absenteeism of the workers in the control area. Therefore, the GSA concluded that air conditioning in the work place does increase work production.[46]

12. Horowitz and Otto - They engaged in a project to design and build an alternate teaching facility: a classroom at the University of Alberta, Canada. Thereupon, they researched how this new classroom affected the learning of students attending classes in this facility.[47]

Their objectives in designing and building the alternate teaching facility were:

To create a versatile classroom.

To equip the classroom with visual stimulants.[48]

To create a lounge type classroom.

The new classroom consisted of moveable partition panels, portable seats, and moveable lighting fixtures. These fixtures were also dimmable. Hence, the instructor could use the seats, partitions, and lights to create the desired learning situation. In addition, the classroom interior was finished in several bright colors to stimulate the students' visual senses. The seats and partition panels were of varying geometric forms, thereby further stimulating student visual senses.[49]

Two sections of a term-length undergraduate English course participated in the study. The same instructor taught each section. One section attended class in the alternate teaching facility; whereas, the other section attended class in a control room. The control room had no windows, a fairly low ceiling, and permanently fastened chairs. Moreover, this room exhibited a propensity for echo.[50]

Students in both sections possessed essentially the same level of learning ability. The researchers confirmed this fact by administering a general intelligence test to both sections at the start of the course.[51]

The dependent variable in the research was student performance as measured by grades on two term papers and a final written exam. The study results indicated no significant difference between the average grades of the two sections. Hence, the researchers concluded that the alternate teaching facility was as conducive to learning as was the control classroom.[52]

The researchers pointed out that grades alone did not reflect what transpired in the two sections. First, attendance in the experimental classroom was far better than attendance in the control room.[53]

Second, the instructor noticed that students in the experimental section began to participate in classroom discussions much earlier in the term than did the students in the control room. The instructor observed that by mid term, the students in the experimental section actively debated quite freely among themselves and with the instructor. These debates occurred with little urging by the instructor. On the other hand, the instructor was forced to prod the control room students to participate in classroom discussions throughout the term. He felt that, by and large, the control room students were content to sit silently through most classes.[54]

Third, the instructor sensed more group cohesion and informality among students in the experimental room than among those in the control room. Students from the

experimental room visited the instructor's office more frequently than did those from the control room. Lastly, the instructor felt that the experimental room students were more at ease during these office visits than were the control room students.[55]

Therefore, the researchers further concluded that the effect of the alternate teaching facility was to increase informal interaction both among students and between the students and their instructor.[56]

13. Cruickshank and Quay - They argued that the nature of the physical classroom environment should be based on empirical evidence about the capacity of children to learn in that environment. Instead, current classroom designs are based more on convenience, features, and the best guesses of educators and architects regarding how to meet educational needs. Moreover, educational needs are translated to design and construction without first being submitted to experimental design or field testing.[57]

Hence, they advocated research in construction design of educational facilities. They stated that this research must relate educational theory to the specifics of environmental design. They called for classical control group design of this research. In other words, one group experiences a test classroom environment and another does not. In this way, they proposed linking the effects of an experimental classroom design to measurable

student behavior. However, they noted that differences in behavior among the two groups of students may also result from extraneous factors rather than solely from the effects of environmental variables.[58]

14. Bursill - He determined the effects of high thermal conditions on the quality and direction of human attention. He defined attention as the degree which an operator could successfully notice and respond to peripheral stimuli while engaged in a continuous central task.[59]

The operators were eighteen naval volunteers who ranged in age from eighteen to thirty-two years. The majority were below age twenty-five. They sat in an apparatus which contained a visual display. Their central task was to keep a pointer on top of a moving object in the display. This object moved at varying speeds and varying directions.[60]

The peripheral stimuli consisted of six neon bulbs placed in a semi-circle at the same radius from the operator. Three bulbs were to the left of the operator. To the right of the operator, the remaining three bulbs mirrored the locations of the first three bulbs. While operators performed the central task, these bulbs lighted in a random manner. When operators noticed a lighted neon bulb, they depressed on a keyboard the number which corresponded to the location of the lighted bulb.[61]

During the test, Bursill placed the operators under two conditions of thermal stress: seventy degrees Fahrenheit dry bulb/sixty degrees Fahrenheit wet bulb, and 105 degrees Fahrenheit dry bulb/ninety-five degrees Fahrenheit wet bulb.[62]

The operators were less efficient in noticing and responding to peripheral stimuli in the higher thermal condition than in the cooler thermal condition. On the average, operators missed thirty-three percent of the peripheral signals in the warmer thermal environment. On the other hand, they missed an average of twelve percent of these signals in the cooler environment. Hence, Bursill concluded that the increased restriction in the operators' fields of vision in the heat was caused by alterations in the operators' central levels of attention.[63]

15. Tognoli - He conducted a study to determine how different classroom settings alter student attitudes and retention. His independent variables in the classroom settings were:

The presence or absence of a window.

Embellished or unembellished surroundings.

A hard or soft chair.[64]

He varied classroom settings among two classrooms, eight settings in all:

Window/embellished surroundings/soft chair.

Window/embellished surroundings/hard chair.

Window/unembellished surroundings/soft chair.

Window/unembellished surroundings/hard chair.

No window/embellished surroundings/soft chair.

No window/embellished surroundings/hard chair.

No window/unembellished surroundings/soft chair.

No window/unembellished surroundings/hard chair.[65]

Embellished surroundings contained colored drawings on the walls and a carpeted floor; unembellished surroundings did not. The soft chair had a bright yellow, upholstered seat with back. The hard chair was a wooden oak chair.[66]

Subjects in the study were fifty-six undergraduate students at a university in New York. Each student was placed singly in one of eight classroom settings. After the students received oral instructions, they viewed a video tape. Then they completed a questionnaire which tested their retention of the information presented in the video tape. Students also completed a second questionnaire in which they rated their classroom setting in terms of interest, pleasantness, distractingness, and comfort.[67]

The questionnaire results indicated that the conditions most conducive for retention were a soft chair

with a window or a hard chair without a window. Conversely, students committed the greatest number of errors on the retention questionnaire in the following conditions:

Window/unembellished surroundings/hard chair.

Window/embellished surroundings/hard chair.

No window/unembellished surroundings/soft chair.[68]

Students rated the embellished surroundings more interesting than the unembellished surroundings. Window and chair type did not significantly impact student interest.[69]

Student ratings indicated that the window setting was more pleasant than the windowless setting. Moreover, they rated the embellished surroundings more pleasant than the unembellished surroundings. Chair type did not significantly impact student ratings of pleasantness.[70]

Students exhibited no significant difference among the various settings regarding their attitudes concerning distractingness.[71]

Finally, students judged the window/embellished surroundings/hard chair setting as most comfortable. On the contrary, they judged as least comfortable the windowless/unembellished surroundings/soft chair setting.[72]

Tognoli concluded that the conditions most conducive to retention resulted from a synthesis of the

subjects' perceptions about the various classroom settings. Further, he noted that the furniture in this study acquired certain values among the subjects. These values were a function of the context in which the furniture appeared. In like manner, Tognoli surmised that the furniture affected the subjects' interpretations of the other aspects of their classroom settings.[73]

Surveying Students about their Physical Learning Environment

1. Bradburn and Sudman - Memory factors most influenced the responses of individuals whom they surveyed using nonthreatening questions. In contrast, question structure and question length did not significantly affect responses to nonthreatening questions. Nonthreatening questions were those about activities or subjects which did not make most people uneasy.[74]

2. Canter - He defined places as units of experience within which activities and physical form were amalgamated. Specifically, he addressed situations in which people worked and lived. He discussed evaluating places by asking people to indicate where a place was located on a numerical scale ranging from most satisfactory to least satisfactory. He noted the 1962 Lowenthal, Lowenthal, and Reil study in which investigators asked observers to assign a number from 1 to

7 for various attributes of a place. A "1" indicated the minimum attribute while a "7" indicated the maximum.[75]

3. Williams - Samples give us information about large groups. A large group is our target population: the group about which we seek information. We can objectively assess and relate sample results to our target population if we perform statistical samples. Statistical samples are those selected by a specified random process. In fact, statistical samples are almost always more accurate than surveying 100 percent of the target population.[76]

Simple random sampling without replacement gives each member of the target population an equal chance of being selected for the sample. In one way of executing this selection process, we assign each member of the target population a number. After mixing these numbers together, we select one. Without replacing this number, we select another. We continue this selection process until we attain the desired quantity of individuals to comprise our sample population.[77]

In practice, there is no easy method to determine sample size. An accepted formula to estimate sample size requires the specification of three things prior to conducting a survey:

Required precision of the results.
Measure of the population variability.
Acceptable risk that the sample does not truly represent the target population.[78]

However, we can't measure the variability of the population until after completing the sample. Thus, we often estimate sample siz based on the sizes of similar samples which we've already conducted.[79]

Two types of errors may affect sampling results: sampling and nonsampling errors. Sampling error refers to sample variability: the chance that one sample will almost always differ from another, even when sampling the same target population in the same random way. Sampling error does not imply mistaken results. Rather, sampling error connotes the fact that estimates differ from one another solely as a result of random selection.[80]

On the other hand, nonsampling error refers to mistaken results. Nonsampling errors are mistakes in sampling data caused by other than random variables. For example, survey personnel commit nonsampling errors when they incorrectly record results during an interview. Nonsampling errors can cause sampling estimates to inaccurately represent the target population. Evidence exists that the larger the sample size is, the larger the percentage of nonsampling errors will be.[81]

Statistical bias may distort our sample results. There are three sources of statistical bias: technical, selection, and measurement error. Technical bias results from the algebraic formulas which we use to estimate the true mean and variance of the target population based on

our sample results. We produce selection bias when we don't select our sample according to our established guidelines. Finally, we introduce measurement errors into our sampling data when we mishandle or improperly record these data. We further introduce measurement error when we use imprecise definitions in our survey instruments. Long interviews can also cause measurement error.[82]

4. Oppenheim - Analytical surveys explore the relationship between particular variables. We study the effects of experimental variables. Dependent variables are the results or predicted outcome of our study. Factors which we control or eliminate as a source of variation in our study are controlled variables. Finally, sources of variation which we can't control are uncontrolled variables.[83]

Possible sources of survey error are:

Faulty interpretation of the survey results.

Nonresponse to the survey.

Respondent bias to the survey's wording.

Survey unreliability.

An invalid survey.

Respondent misunderstanding or mistakes.[84]

With no interviewer to provide additional information or explanation, written surveys must stand on their own. Therefore, survey questions must be simple. Response rates for written surveys traditionally range

from forty to sixty percent. To encourage responses, survey data should be treated confidentially. When possible, do not ask respondents to place their names on their responses.[85]

Sequence survey questions to avoid putting ideas in the minds of respondents early in the survey. Start the survey with easy, impersonal questions. Question length should be short: no more than twenty words. Use simple, familiar words in questions.[86]

A brief written explanation should precede the survey. This explanation produces a positive feeling among respondents by summarizing the survey's purpose, how respondents were selected, and the confidentiality of responses.[87]

Closed questions offer respondents a choice of alternative replies. These replies contain terms which respondents understand and which succinctly express the views of the respondents. One danger exists in providing respondents with alternate replies to questions. This danger is the impact of the Halo effect on the data: when respondents are influenced by an overall feeling of like or dislike as they choose responses. Accordingly, they don't pay close attention to individual questions.[88]

Survey designers are concerned with the reliability and validity of their surveys. A reliable survey consistently achieves the same results. A valid survey

measures what the designers intend it to measure. Internal checks in the survey ascertain reliability. Normally, these checks consist of repeating some questions using slightly different wording. Thereupon, responses for similar questions are compared to determine the survey's reliability. A survey is validated by piloting or testing the final version of the survey on individuals who are not part of the sample population. Survey designers use the feedback that they receive during validation to reword or revise questions, as needed, prior to surveying the sample population.[89]

5. Sudman and Bradburn - Question wording impacts greatly on survey validity: the degree to which a survey elicits the information that the researcher desires. For questions about attitudes, however, the meaning of survey validity is not altogether clear. Nevertheless, it is certain that small changes in the wording of attitudinal questions may produce large differences among the replies of respondents.[90]

The best way to begin writing attitude questions is to use good quality questions from previous surveys. One technique to validate these questions is to ask trial respondents to explain out loud to the researcher their understanding of the meaning of each question.[91]

The most frequent method to measure the intensity of attitudes is to build an intensity scale into the

survey's response categories. Unless visual cues are part of the survey, limit the number of intensity scale responses to four to five. Respondents cannot remember more than five different responses.[92]

Begin surveys with easy, nonthreatening, but necessary questions. Keep the survey as short as possible. For mail surveys, hold the number of open questions to a minimum. Furthermore, limit mail surveys to two to four pages. Put the study's justification in a letter that accompanies the mail survey. This letter should be no longer than one page; otherwise, respondents will only skim the letter or will skip it completely. Include in this letter:

Purpose of the study.

Importance of respondents

Promise of confidentiality.

Thanks.[93]

To ensure ease of reading, compile the survey in the booklet format. Print surveys using large, clear type. Include in the survey the date, the study title, and the organization conducting the study. Number survey questions; never split a question between two pages. When using an intensity scale for the response categories of closed questions, list the scale vertically[94].

Summary

My literature review revealed numerous concepts and techniques which I applied during the design and execution of my study. First, the construction and use of a prototype classroom was an accepted method of evaluating a design to renovate the CGSOC classrooms. Particularly important in this evaluation process was the application of lessons-learned to future design efforts. A key source for evaluative criteria was the U.S. Army Service Schools Design Guide.

Next, student perceptions about their physical learning environment were influenced heavily by their individual classroom experiences. The nature of these experiences required that I collect and analyze subjective data in my study. As a consequence, I also chose to confirm or refute these data by empirically measuring various physical properties of the model classroom and a conventional classroom.

The TRADOC study that I reviewed established the need for continued research regarding the relationship of classroom design to the quality of physical learning environments within TRADOC. Thus, my study contributed to TRADOC's research.

Herzberg, Mausner, and Snyderman's research suggested that the classroom's interior design was a dissatisfier: a factor that affected student perceptions

in a negative manner. A well designed classroom might, at best, eliminate students' dissatisfaction with their physical learning environment. Thereafter, only the presence of satisfiers in the classroom would enhance student learning. Consequently, it might be necessary to design and build a classroom facility of no better quality than that required to eliminate dissatisfiers to student learning. Once at this level of quality, classroom satisfiers such as teacher personality, instruction techniques, or course content would then enhance the quality of student learning.

On the other hand, social scientists and educators have conducted research which demonstrated a direct relationship between interior design and the quality of the physical learning environment. In particular, their research showed that the following aspects of classroom interior design impacted on the physical learning environment for the students:

Heating and air conditioning.

Ventilation.

Lighting.

Insulation from external noise.

Visual aesthetics.

Classroom setting or arrangement.

Furniture.

Individual space.

With the exception of visual aesthetics, I considered these interior design aspects when I designed a survey to collect student perceptions about their physical learning environment. None of the researchers whom I reviewed portrayed that he had isolated the effect of individual aspects of classroom interior design on the quality of the physical learning environment. Instead, these researchers contended that all aspects of the classroom's interior design worked together to influence the quality of the physical learning environment. This combined influence of all aspects of the model classroom's interior design improvements would impact my analysis of student perceptions about their physical learning environment.

Researchers measured how classroom interior design affected physical learning environment in almost as many ways as there were studies. They measured student grades in college courses, student performance on short duration written tasks or practical exercises, student perceptions of their physical learning environment, student perceptions of their teacher, student-teacher interactions, and classroom participation. I chose to measure student perceptions about their physical learning environment.

Researchers used the control group technique most frequently in the studies that I reviewed. In each study,

the independent variable was the classroom's interior design; whereas, the dependent variable was the researcher's measure of the quality of the physical learning environment. These studies involved two physical areas: control and experimental. Researchers established in the control area what they perceived to be minimally acceptable standards for a classroom's interior design. In the experimental area, they effected improvements to the control conditions. They drew conclusions about the impact of the experimental conditions on the quality of the physical learning environment after comparing their measured data from the two areas. I chose to employ this control group technique in my research.

My review of survey literature aided my efforts to design the requisite means to collect student perceptions about the quality of their physical learning environment. I devised numerous nonthreatening statements about the physical learning environment in CGSOC classrooms. In turn, I offered respondents a certain range of choices with which to express their perceptions about these statements. The survey instrument was in writing; therefore, it had to be clear and concise. A brief letter of instruction and explanation accompanied the survey statements. Finally, I chose to statistically sample the experimental and control groups.

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CHAPTER 3

METHODS AND PROCEDURES

Study Design

I surveyed CGSOC students in section 23 (the model classroom) and in section 21 (a conventional classroom) about their physical learning environment the week of 10 December 1990: the last full week of term I. During term I, students in sections 21 and 23 attended six mandatory courses in only their respective classrooms. Hence, those surveyed had from 9 August 1990 to 10 December 1990 to experience the physical learning environment of their classroom. In these five months, students completed 406 hours[1] of instruction or an average of 4.5 hours per work day spent in their assigned classroom.[2]

I compared the survey data from section 23 with those from section 21 to determine significant differences. These differences, then, indicated the effect of the model classroom's interior design improvements on student perceptions about their physical learning environment.

Other than the model classroom's interior design improvements, the learning environments for sections 21 and 23 were essentially the same during term I. Students in both sections attended the same six mandatory courses in the same sequence. Moreover, classroom 21 is located immediately next to classroom 23 on the same side of the academic building. Therefore, outdoor environmental conditions such as wind and sunlight should have similarly affected both classrooms.

Table 1 compares the interior design features of the model classroom (classroom 23) with those of classroom 21: the conventional classroom.

TABLE 1: INTERIOR DESIGN FEATURES

MODEL CLASSROOM	CONVENTIONAL CLASSROOM
Operable acoustical interior walls divided classroom into quadrants.	Accordion-fold partitions divided classroom into quadrants.
Separate entrances to each classroom quadrant.	One entrance for each of two classroom quadrants. Students entered the remaining two quadrants by first passing through the quadrants next to the entrances.
Independently controlled heating and cooling in each quadrant.	Heating and cooling of the classroom controlled from the Bell Hall heating and cooling plant.
Heating/cooling supply air ducts and return air vents in the ceiling of each quadrant.	Heating/cooling supply and return air ducts for the entire classroom located on one outer wall.

TABLE 1(CONTINUED): INTERIOR DESIGN FEATURES

MODEL CLASSROOM	CONVENTIONAL CLASSROOM
Acoustical tile ceiling.	Acoustical tile ceiling.
Indirect fluorescent lighting.	Direct fluorescent lighting.
Adjustable incandescent spot lighting.	N/A.
Carpeted raised floor.	Carpeted concrete floor.
One ceiling-mounted projection screen per quadrant: 48 square feet of projection surface.	One portable, free-standing projection screen per quadrant: 24 square feet of projection surface. Portable screen occupied 18.5 square feet of usable floor space per quadrant.
Wall-mounted dry wipe marker boards in each quadrant: 50 square feet of marker surface.	One portable chalkboard per quadrant: 46 square feet of chalkboard surface. Portable chalkboard occupied 16 square feet of usable floor space per quadrant.
Wall-mounted tack boards in each quadrant: varied tackable surface area.	Wall-mounted tack boards in each quadrant: varied tackable surface area.
Tackable surface on operable interior walls: 376 square feet of tackable surface per quadrant.	Two portable tack boards per quadrant: 160 square feet of tackable surface. Tack boards occupied 28 square feet of usable floor space per quadrant.
Ten multi-purpose floor outlets per quadrant. Two duplex electrical receptacles, one telephone jack, and one computer connection per outlet.	N/A.

TABLE 1(CONTINUED): INTERIOR DESIGN FEATURES

MODEL CLASSROOM	CONVENTIONAL CLASSROOM
Two wall-mounted duplex electrical receptacles per quadrant.	One or two wall-mounted duplex electrical receptacles per quadrant.
One audiovisual equipment and classroom material storage cabinet recessed in the wall of each quadrant: 38 square feet of storage space per cabinet.	Audiovisual equipment stored on one portable cart in each quadrant. Portable cart occupied 5 square feet of usable floor space per quadrant. No classroom material storage cabinets in quadrants.
One 26 inch color television/monitor with two 2.5 inch speakers per quadrant.	One 19 inch color television (mono sound) per quadrant.
One 3/4 inch video cassette player per quadrant.	One 3/4 inch video cassette player per classroom.
One 35mm slide projector per quadrant.	One 35mm slide projector per classroom.
One 1/2 inch video cassette player per quadrant.	One 1/2 inch video cassette player per classroom.
One overhead projector with equipment cart per quadrant. Cart occupied 3 square feet of usable floor space per quadrant.	One overhead projector with equipment table per quadrant. Table occupied 6 square feet of usable floor space per quadrant.
Individual student desk: 6 square feet of desk top, plus a bookshelf. Seventeen desks per quadrant; they occupied 102 square feet of usable floor space per quadrant.	Work table: eighteen square feet of desk top, two students per table. Eight tables per quadrant; they occupied 144 square feet of usable floor space per quadrant.
Shock absorbing chairs with arms, on casters.	Padded metal chairs with arms, straight-legged.

TABLE 1(CONTINUED): INTERIOR DESIGN FEATURES

MODEL CLASSROOM	CONVENTIONAL CLASSROOM
One computer work station complete with personal computer, monitor, and printer per quadrant. Work station occupied 11 square feet of usable floor space per quadrant.	One computer work station complete with personal computer, monitor, and printer per quadrant. Work station occupied 11 square feet of usable floor space per quadrant.
N/A	Elevated stage with large projection screen: 62 square feet of projection surface. 250 square feet of stage area.
22 square feet of window surface in each of the two quadrants along the building's outside wall. Hinged marker boards served as blinds and covered these windows when needed.	87 square feet of window surface in each of the two quadrants along the building's outside wall. Vertical, cloth blinds covered these windows when needed.

In addition, I surveyed students attending a term II elective course in classroom 23 about their physical learning environment. From 11 to 14 February 1991, I surveyed students in the sixteen classes attending elective A451, Logistics For Commanders. Four classes met in the model classroom each day: one class per quadrant. Students attending this elective had met in the model classroom once a week for five weeks prior to the date on which the survey was administered. Weekly meetings lasted three hours. I discarded from the February survey the results of any section 23 students who attended this term II elective.

I compared the data from this term II survey with those from the term I survey to again identify significant differences. These differences demonstrated the impact of classroom 23's interior design improvements on student perceptions about physical learning environment for students who initially experienced only conventional classrooms, and subsequently were exposed to the model classroom.

I also measured the following physical characteristics of the model classroom and the conventional classroom to validate the subjective survey data:

Sound transmission through the operable walls.

Available light.

Temperature and humidity.

Floor space per quadrant.

As a student in classroom 23, I collected data regarding the quality of the model classroom's physical learning environment. I also recorded unsolicited comments from students and faculty, alike, regarding the quality of classroom 23's physical learning environment. In order not to bias student opinions about the model classroom, I made no attempt to solicit data from students other than the formal surveys.

Population

These groups made up the survey target populations:

Group A - Sixty-four students in section 21.

Group B - Sixty-four students in section 23.

Group C - 247 students attending the term II elective, A451: Logistics For Commanders.

Groups A and B each consisted of four 16-person staff groups. Group C amounted to four classes per day: one class in each quadrant of the model classroom. Class size varied from thirteen to seventeen students. The following number of students attended A451 each day:

Monday - Sixty-three students.

Tuesday - Sixty-five students.

Wednesday - Fifty-five students.

Thursday - Sixty-four students.

I selected students to survey by simple random sampling without replacement. My sample size for each group was seventy percent of the target population. Using this same sample size for a classroom of sixty-four students, the College's Evaluation and Standardization Division had achieved a confidence level of eighty-five percent for data from similar attitudinal surveys.[3] Accordingly, I surveyed forty-five students in group A and in group B. In like manner, I surveyed forty-five students daily in group C for a total of 180 group C students.[4]

Data Collection Instrument

Initially, I devised twenty-nine statements to collect student perceptions about the effect of the following aspects of interior design on the quality of the physical learning environment in CGSOC classrooms:

Climate control.

Lighting.

Acoustics.

Access/exit.

Furniture.

Support equipment.

Space.

Flexibility.

To check the survey's reliability, I repeated eleven statements in a similar, but not identical manner. Thus, the number of statements increased to forty. In addition, I added one question to the survey in order to solicit from students their written suggestions to make the physical classroom environment more conducive to learning. Finally, I included a classroom chart in the survey. The purpose of this chart was to solicit from students a location in their quadrant where they felt most comfortable under various conditions. Appendix II lists the forty statements, the question, and the chart.

I chose the Likert scale for students to evaluate the forty survey statements:

Strongly agree.

Agree.

Neither agree nor disagree.

Disagree.

Strongly disagree.

I validated the survey with several CGSOC students assigned to sections other than 21 or 23. On 10 December 1990, the College approved the survey and assigned a control number (Appendix III).

Prior to surveying students attending the term II elective course, I revalidated the survey with the elective course's author and eliminated twelve statements from the survey. The change reflected the fact that the elective course's instruction did not use the following aspects of the model classroom's interior design:

Rearrangement of furniture to form work groups.

Air conditioning.

Personal computer.

Opening or closing the operable walls.

Storage space.

[illegible]k boards.

Moreover, I eliminated the classroom chart from the term II survey because it had yielded little useful data during the term I survey. During the term I survey, most students completed this chart incorrectly or not at all.

Data Collection Methods

On 10 December 1990, I placed surveys for the sample population in the appropriate student distribution boxes for sections 21 and 23 (Appendix IV). This survey procedure was essentially the same as administering a mail survey. Students had one week to complete the surveys and return them to their student survey representative. The representatives returned the surveys to me.

The four instructors for the term II elective administered the survey at the start of their respective classes on 11, 12, 13, and 14 February 1991 (Appendix V). The instructors returned the completed surveys to me immediately after collecting them from their students.

In July 1990, I measured floor space in the model classroom and in classroom 21: the conventional classroom. Table 2 summarizes my measurements.

TABLE 2: FLOOR SPACE (SQUARE FEET) COMPARISON

AREA	MODEL CLASSROOM	CONVENTIONAL CLASSROOM
QUADRANT A	573	732
QUADRANT B	573	600
QUADRANT C	655	600
QUADRANT D	645	660
TOTAL	2,446*	2,592*

*Excluded from this total is floor space in each classroom's storage rooms, coat room, and entrance hallways. Floor space in these areas did not contribute to the physical learning environment in either classroom's quadrants.

On 2 October 1990, I used a Weston Illumination Meter, Model 756, to measured available light in the center of each quadrant in the model classroom. In like manner, I measured available light in classroom 21. Table 3 summarizes my measurements.

TABLE 3: AVAILABLE LIGHT (FOOTCANDLES) COMPARISON

CLASSROOM 21

	All Fluorescent	Two-thirds Fluorescent	One-third Fluorescent
QUADRANT A	52	38	14
QUADRANT B	54	40	16
QUADRANT C	67	47	25
QUADRANT D	45	35	14

CLASSROOM 23

	All Fluorescent and Incandescent	All Fluorescent	One-half Fluorescent	Incandescent Only: Max Brightness
QUADRANT A	74	59	30	16
QUADRANT B	76	58	28	18
QUADRANT C	78	64	32	15
QUADRANT D	76	63	35	14

U.S. ARMY SERVICE SCHOOLS DESIGN GUIDE REQUIREMENTS[6]

For general classroom activities - 70 footcandles.
For reading textbooks and notes - 50 footcandles.
During audiovisual presentations - 30 footcandles.

Classroom 21's ceiling lights were 3-tube fluorescent, direct light fixtures. Two light switches in each of classroom 21's quadrants controlled one-third and two-thirds of the tubes, respectively. Classroom 23's ceiling lights were 2-tube fluorescent, indirect light fixtures. These fixtures were suspended in a wood frame grid below the acoustical tile ceiling in each quadrant. The tubes shone upward, reflecting light off the ceiling tiles and down to each classroom quadrant. Two light switches in each of classroom 23's quadrants controlled one-half of the tubes, respectively. A dimmer switch in each quadrant controlled the incandescent spot lights.

Also on 2 October 1990, I measured the amount of sound transmitted through the partitions in classroom 21 and through the operable walls in the model classroom. These partitions and operable walls separated quadrants in the respective classrooms.

Using a Quest Electronics Integrating Sound Level Meter, Model 228, I measured decibels of sound from the center of one quadrant in the model classroom while a member of the College staff read aloud some printed material in each of the three adjacent quadrants. (Normal voice conversation is approximately 60 to 80 decibels.)[7] In this way, I attempted to simulate classroom conditions in the quadrants adjacent to the one in which I was measuring transmitted sound. I repeated this measurement procedure for the remaining quadrants in the model classroom and for those in classroom 21. No one read in the quadrant where I was recording the decibel measurement. I operated no electrical equipment, other than ceiling lights, in the quadrant where I was measuring transmitted sound.

Table 4 summarizes the decibel readings. These data indicated that during my test classroom 21's interior partitions transmitted more sound from adjacent quadrants than did classroom 23's interior operable walls.

TABLE 4: SOUND TRANSMISSION (DECIBELS) COMPARISON

CLASSROOM 21

QUADRANT	DECIBELS OF SOUND IN MEASURED QUADRANT
A	52
B	49
C	52
D	51

CLASSROOM 23

QUADRANT	DECIBELS OF SOUND IN MEASURED QUADRANT
A	45
B	45
C	41
D	41

Using a sling cyclometer, I measured and recorded temperature and humidity in classrooms 21 and 23 on the following dates:

2 October 1990.

2 November 1990.

6 December 1990.

17 January 1991.

8 February 1991.

7 March 1991.

These readings are listed in Appendix VI.

Finally, I recorded in a spiral notebook unsolicited comments from students and faculty as well as my own observations about the model classroom's physical learning environment. Because I carried this notebook with me to class each day, I was able to record comments and observations as they occurred.

Procedures for Analysis

Students recorded survey responses on CGSC Form 96: a computer mark sense data sheet. I used computer equipment in the College's Department of Automated Command and Training Systems to read, then load the data onto a floppy disk. Thereupon, I created a data file for use in the Statistical Package for the Social Sciences (SPSS) software maintained by the College's Evaluation and Standardization Division.

Using SPSS, I compared the responses of the three groups of students to each statement and performed a statistical analysis of the frequencies for each response. In doing so, I obtained the Chi-Square value for each set of responses. This value indicated the degree of independence of any two students choosing a particular response. Significant differences from the expected frequencies of responses displayed that student perceptions about their physical learning environment were not random, but were the result of classroom interior design.[8]

Statistical significance is the amount of certainty that the study's dependent variable -- student perception about the CGSOC physical learning environment -- was not attributable to chance. Stated differently, statistical significance is the degree to which the study's independent variable -- classroom interior design -- effected the dependent variable. By choosing a .05 level of significance, I was 95 percent certain that statistically significant differences among students' perceptions about their CGSOC physical learning environment were attributable to their classroom's interior design.[9]

In addition, I analyzed the written student responses to question 42 and to question 43 (term I survey only). Further, I supplemented these survey data with my empirical measurements and with information contained in my recordings of unsolicited comments and personal observations.

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United States Army Command and General Staff College Catalog. Academic Year 1990 - 1991, 45 - 48, 51 - 52.

2
Calculations to determine the average number of hours per work day spent in assigned classrooms during term I:

Work weeks during term I = 19.
Work days per work week = 5.
Work days during term I: 19 X 5 = 95.
Holidays during term I = 5.
Revised total work days during term I = 90.
Course hours during term I = 406.
Average classroom hours per day: 406/90 = 4.5.

3
From author interview with Mr. David W. Kent, Evaluation and Standardization Division, Directorate of Academic Operations, U.S. Army Command and General Staff College on 31 October 1990.

4
The exact sample sizes for each day of the elective course should have been:

Monday	-	44 students.
Tuesday	-	46 students.
Wednesday	-	39 students.
Thursday	-	45 students.
Total	-	174 students.

For the sake of simplicity, I elected to select at random 45 students from each day for a total of 180.

5
I measured gross floor space in the quadrants of both classrooms. In classroom 21, the conventional classroom, I did not include the stage area or the large projection screen area in my measurement of gross floor space.

6
U.S. Department of the Army, Design Guide 1110-3-106: Department of the Army Design Guide for U.S. Army Service Schools (Washington, D.C.: Government Printing Office, May 1986), 3-5, 4-49.

7
Ibid., 3-8.

8
Mr. David W. Kent, on 25 April 1991.

9
Ibid., on 22 March 1991.

CHAPTER 4

DATA ANALYSIS

Completed Surveys

Table 5 summarizes the number of completed surveys that I received from the three sample populations: group A - section 21, group B - section 23, and group C - A451, Logistics for Commanders:

TABLE 5: COMPLETED SURVEYS

Computer Mark Sense Sheets: Forty Statements

	Group A	Group B	Group C
Distributed	45	45	180
Returned [1]	28	42	170
Eliminated from data	N/A	N/A	18
Data Base	28	42	152
Response Rate	62.2%	93.3%	84.4%

Recommended Improvements: Question 43

	Group A	Group B	Group C
Returned	5	26	93

Classroom Chart: Question 44

	Group A	Group B	Group C
Returned [2]	5	20	not used in survey

Survey Results: Summary

Student responses to the forty survey statements are summarized in Appendix VII.

Survey Results: Climate Control

Statement 3 (Air is stagnant in staff group area):

	Group A	Group B	Group C
Agree	50%	64%	33%
Neither agree nor disagree	18%	19%	28%
Disagree	32%	17%	39%

When compared to section 21 and elective course students, more than the expected number of section 23 students perceived that the air was stagnant in their staff group area. In contrast to sections 21 and 23, fewer elective course students than expected perceived the air in their model classroom quadrant to be stagnant.

Statement 37 (Comfortable during cold weather):

	Group A	Group B	Group C
Agree	15%	12%	55%
Neither agree nor disagree	15%	17%	32%
Disagree	70%	71%	14%

In comparison to sections 21 and 23, more than the expected number of elective course students felt comfortable in their model classroom quadrant during cold weather. Conversely, over twice the expected number of section 21 and section 23 students disagreed that they felt comfortable in their staff group area during cold weather.

Statement_10 (When heat on, air too dry):

	Group_A	Group_B	Group_C
Agree	11%	48%	30%
Neither agree nor disagree	56%	31%	48%
Disagree	33%	21%	21%

When compared to section 21 and elective course students, more than the expected number of section 23 students perceived that the air in their model classroom quadrant was too dry when the heat was on. Comparing the three groups also revealed that fewer section 21 students than expected perceived that the air was too dry in their staff group area when the heat was on.

Statement_11 (Comfortable when warm outside):

	Group_A	Group_B
Agree	39%	19%
Neither agree nor disagree	4%	19%
Disagree	57%	62%

In comparison to section 23, more than the expected number of section 21 students felt comfortable in their classroom 21 quadrant during warm weather.

Statement_26 (Air conditioning is adequate):

	Group_A	Group_B
Agree	37%	24%
Neither agree nor disagree	11%	24%
Disagree	52%	52%

There was no significant difference between the responses of sections 21 and 23 regarding student perceptions about the adequacy of the air conditioning in classrooms 21 and 23.

Statement_32 (Too humid inside when humid outside):

	Group_A	Group_B
Agree	33%	36%
Neither agree nor disagree	37%	33%
Disagree	30%	31%

There was no significant difference between the responses of sections 21 and 23 regarding student perceptions about the humidity in the two classrooms when it was humid outdoors.

Prior to the start of my study I did not anticipate that students would respond as they did to the previous six statements regarding climate control in the two classrooms. Indeed, with independent climate controls in each quadrant, I expected students in the model classroom to perceive their environmental conditions more positively than would section 21 students. Instead, students generally perceived in like manner the climatic conditions in the model classroom and in conventional classroom. In one instance -- dryness of the air when the heat was on -- model classroom students' perceptions about their environment were worse than those of section 21 students.

The reasonable explanation for students similarly perceiving the environmental conditions in the two classrooms was the fact that the model classroom's heating, ventilation, and air conditioning (HVAC) system did not function as intended during the survey period.

First, malfunctioning thermostats together with an inoperative thermal mixing coil repeatedly created uncomfortably warm or uncomfortably cool conditions in the model classroom quadrants from September 1990 to January 1991.[3]

Next, engineers at the Fort Leavenworth Directorate of Engineering and Housing identified an additional problem in the model classroom's HVAC system after the contractor had replaced the malfunctioning HVAC component parts. These engineers noted that the model classroom's HVAC system would not always respond to thermostat demands for heated or cooled air. The reason for this lack of response was the fact that the model classroom's HVAC units were supplied with chilled or heated water from Bell Hall's mechanical plant. This plant only produced heated water during the heating season. Accordingly, model classroom HVAC units could only supply heated air during the heating season. In like manner, classroom 23's HVAC units could only supply quadrants with cooled air during the cooling season.[4]

In light of the problems associated with the model classroom's HVAC system, student responses to the survey's climate control statements made sense. Instead of environmental conditions which model classroom students could independently control by quadrant, climatic conditions in classroom 23 more or less mirrored those of

the conventional classroom. During my monthly checks from October 1990 to March 1991, the average climatic conditions among quadrants in classrooms 21 and 23 were almost identical:

Classroom 21 -	74.8 degrees Fahrenheit. 32 percent relative humidity.
Classroom 23 -	73.8 degrees Fahrenheit. 31 percent relative humidity.

Hence, it followed that model classroom students (groups B and C) perceived their climatic conditions in a manner similar to section 21 students, with one exception: air quality. Whereas students in classroom 21 could open a window, model classroom students had no access to an operable window. When environmental conditions in classroom 21 became warm or stuffy, students routinely opened the window to aid climactic control of their classroom.[5] Open spaces above and below classroom 21's interior partitions permitted the circulation of outside air supplied by the opened window.

On the contrary, model classroom students could not similarly attempt to regulate their classroom's environmental conditions. The model classroom windows did not open. Furthermore, the interior operable walls created an effective environmental seal among quadrants as well as an acoustical seal. Thus, when the model classroom's air handling unit was not supplying air to these quadrants, students may have perceived their staff

group area as stuffy. This situation may explain why a larger percentage of section 23 students perceived the air to be stagnant in their staff group area in comparison to section 21 students.

In addition, the average environmental conditions in both classrooms during my monthly checks differed from those specified in the U.S. Army Service Schools Design Guide:

Cooling Season (October 1990)	Temperature (Fahrenheit)	Relative Humidity
Classroom 21	74 degrees	54 percent
Classroom 23	70 degrees	59 percent [6]
Design Standard	78 degrees	30 to 70 percent

Heating Season (November 1990 to March 1991)	Temperature (Fahrenheit)	Relative Humidity
Classroom 21	75 degrees	28 percent
Classroom 23	74 degrees	26 percent [7]
Design Standard	68 degrees	30 to 70 percent

The fact that the air in the model classroom was, on the average, drier than that of classroom 21 may explain why more than the expected number of section 23 students perceived the air in their staff group area as too dry when the heat was on.

Students submitted numerous written complaints about climatic conditions. In fact, they mentioned no other subject more frequently than an improved HVAC system as a recommendation to make the CGSOC classroom environment more conducive to learning. Nineteen section 23 students recommended improving the model classroom's

HVAC system. Thirty-two elective course students made similar recommendations. In contrast, only three section 21 students recommended improving their HVAC system.

This difference in the number of recommendations between section 21 and model classroom students (groups B and C) may have resulted from differences in climate control expectations. Whereas the model classroom was touted for its independent HVAC controls in each quadrant, the conventional classroom had no such controls. As a consequence, model classroom students probably expected to have more control of their environmental conditions than did section 21 students. Instead, classroom 23's HVAC controls failed to work properly and, on occasion, created uncomfortable climatic conditions. In turn, model classroom students may have perceived their HVAC system more negatively than did section 21 students. The by-product of these negative perceptions might have been the significantly greater number of written student comments about classroom 23's HVAC system in comparison to those about classroom 21's system.

Survey Results: Lighting

Statement 4 (Enough light to read text and notes):

	Group A	Group B	Group C
Agree	79%	98%	93%
Neither agree nor disagree	4%	2%	3%
Disagree	18%	0%	4%

In comparison to model classroom students (groups B and C), fewer section 21 students than expected perceived enough light in their classroom to read textbooks.

My footcandle measurements confirmed this perception of different light levels between the two classrooms. With all ceiling lights turned on, classroom 21 averaged 54.5 footcandles of light per quadrant; whereas, classroom 23 averaged 76 footcandles per quadrant. When I illuminated only classroom 23's fluorescent ceiling lights -- the common lighting level for most course work -- the model classroom quadrants averaged 61 footcandles of light. While classroom 21's average footcandle level exceeded the U.S. Army Service Schools Design Guide requirement of 50 footcandles[8] to read textbooks, more section 21 students than expected disagreed that they had sufficient light to read textbooks. Thus, this required light intensity may have been too low for these students. Indeed, no section 23 students disagreed with statement 4; these students experienced an average light level of 11 footcandles more than the design guide requirement to read textbooks. Instead, all but one section 23 respondent agreed that there was sufficient light in classroom 23 to read textbooks.

Statement 12 (Window light interferes with AV):

	Group A	Group B	Group C
Agree	14%	0%	2%
Neither agree nor disagree	36%	36%	41%
Disagree	50%	64%	57%

When compared with model classroom students (groups B and C), more section 21 students than expected perceived that window light interfered with audiovisual presentations. In particular, student responses from quadrants C and D -- the two quadrants which contained windows -- demonstrated the differences in student perceptions about window light interference in the two classrooms. More than the expected number of section 21 students in quadrants C and D perceived window light interference. In contrast, no section 23 students in these two model classroom quadrants perceived such interference. Only two of seventy-seven elective course students in quadrants with windows perceived outdoor light interference with audiovisual presentations.

These differences in the perceived degree of window light interference most probably resulted from differences in the window blinds of the two classrooms. The hinged marker boards that closed over classroom 23's windows apparently prevented outdoor light from entering the classroom more effectively than did the vertical cloth blinds in classroom 21. As a consequence, sunlight may have weakened the projected light in classroom 21 to a greater degree than it did in classroom 23.

Statement_27 (Light can be dimmed to enhance AV):

	Group_A	Group_B	Group_C
Agree	78%	100%	65%
Neither agree nor disagree	7%	0%	32%
Disagree	15%	0%	3%

In comparison to section 21, more section 23 students than expected perceived that their classroom lighting could be dimmed to enhance audiovisual presentations and still permit reading of textbooks and notes.

The major determining factor in this perception was probably classroom 23's incandescent spot lights: adjustable from zero to maximum intensity. Still, at maximum intensity these spot lights only produced an average of 16 footcandles of available light per quadrant: This value is much less than the 30 footcandles of light which the U.S. Army Service Schools Design Guide recommends for audiovisual presentations.[9] Quadrants in classroom 21 similarly averaged less than this design guide recommendation when only one-third of the fluorescent ceiling lights were illuminated: 17 footcandles.

With the incandescent spot lights turned off, one-half of classroom 23's fluorescent ceiling lights yielded an average light intensity of 31 footcandles per quadrant: very close to the design guide's recommendation. No such similar light level was

attainable in classroom 21, however. Illuminating two-thirds of the fluorescent ceiling lights in this classroom yielded an average light intensity of 40 footcandles per quadrant.

In the end, the mere presence of adjustable incandescent spot lights in classroom 23 may have been enough to influence section 23 students' perceptions about their ability to dim classroom lighting to enhance audiovisual presentations and still read text and notes.

Statement 34 (Enough light to view boards):

	Group A	Group B	Group C
Agree	81%	98%	87%
Neither agree nor disagree	11%	2%	11%
Disagree	7%	0%	3%

There was no significant difference among the three groups regarding student perceptions about the amount of classroom lighting required to read chalkboards, marker boards, and tack boards.

Statement 20 (Window light creates glare):

	Group A	Group B	Group C
Agree	7%	0%	1%
Neither agree nor disagree	41%	38%	42%
Disagree	52%	62%	56%

There was no significant difference among the three groups regarding student perceptions about outdoor light creating glare on marker boards or chalkboards.

The reason that the majority of model classroom students (groups B and C) disagreed with this statement was readily apparent. As demonstrated in the responses to

survey statement 12, classroom 23's hinged marker boards apparently prevented sunlight from entering the classroom, and thus eliminated sunlight glare on the marker boards. The reason that a majority of section 21 students similarly disagreed that sunlight glare prevented them from reading classroom boards might have been the nature of classroom 21's vertical blinds. Although these blinds did not completely block outdoor light -- as evidenced in statement 12's responses -- they may have filtered or diffused sunlight sufficiently to reduce or eliminate glare on classroom 21's boards.

Survey Results: Acoustics

Statement 13 (Adjacent group noise interferes):

	Group A	Group B	Group C
Agree	82%	14%	9%
Neither agree nor disagree	14%	17%	16%
Disagree	4%	69%	74%

In comparison to model classroom students (groups B and C), over four times the expected number of section 21 students agreed that noise from adjacent quadrants in classroom 21 interfered with their concentration. In contrast, more than the expected number of model classroom students (groups B and C) disagreed with this statement.

Statement 21 (Can hear adjacent groups):

	Group A	Group B	Group C
Agree	100%	33%	25%
Neither agree nor disagree	0%	19%	11%
Disagree	0%	48%	64%

When compared to students in classroom 23 (groups B and C), over twice the expected number of section 21 students perceived that they could hear activities in adjacent staff groups. On the other hand, fewer than the expected number of students in classroom 23 (groups B and C) perceived that they could hear what went on in adjacent quadrants.

Statement 24 (Walls create disturbance-free space):

	Group A	Group B	Group C
Agree	0%	90%	68%
Neither agree nor disagree	7%	2%	23%
Disagree	93%	7%	9%

In comparison to model classroom students (groups B and C), almost five times the expected number of section 21 students disagreed that their interior partitions created a work area free of disturbances from adjacent staff groups. At the same time, more than the expected number of model classroom students (groups B and C) perceived that their interior operable walls created a work space free of disturbances from adjacent quadrants.

My empirical data supported the results of the previous three statements regarding the acoustical separation of quadrants in classrooms 21 and 23. On the average, classroom 21's accordion-fold partitions transmitted 51 decibels of sound during my test. Conversely, classroom 23's acoustical operable walls

transmitted an average of 43 decibels of sound during my test. Thus, it made sense that model classroom students perceived their operable wall acoustical barrier more positively than did section 21 students perceive their partitions as an acoustical barrier.

Furthermore, I anticipated these differences in student perceptions about the acoustical separation among quadrants because of differences in the two classrooms' interior walls. Classroom 21's accordion-fold partitions probably served more as a visual barrier than as an acoustical barrier between quadrants. Only one-half inch thick, these wooden partitions may have failed to effectively absorb or attenuate sound among classroom 21 quadrants. In fact, these accordion-fold partitions were suspended from the ceiling such that an open space existed between the partition track and the ceiling, as well as between the base of the partition and the carpeted floor. Sound travelled unhampered through these open spaces.

In contrast, classroom 23's interior operable walls were designed to absorb or attenuate the sound within each quadrant. Moreover, the model classroom's three inch thick fabric-covered operable walls fastened together to form acoustical seals both vertically between wall sections and horizontally at the top and bottom of wall sections.

Statement 28 (Can hear instructor from anywhere):

	Group A	Group B	Group C
Agree	78%	98%	94%
Neither agree nor disagree	0%	0%	6%
Disagree	22%	2%	0%

In comparison to model classroom students (groups B and C), fewer section 21 students than expected agreed that they could hear their instructor from anywhere within their quadrant. Yet, more than the expected number of model classroom students (groups B and C) agreed with this statement.

Statement 6 (Noise within prevents concentration):

	Group A	Group B
Agree	61%	29%
Neither agree nor disagree	21%	21%
Disagree	18%	50%

When compared to section 23, more than the expected number of section 21 students perceived that their concentration was affected by noise from other work groups within their staff group. On the contrary, fewer section 23 students than expected perceived that noise from their own quadrant's work groups affected their concentration.

Responses to the previous two statements indicated that model classroom students perceived the internal acoustical properties of their quadrants more positively than did section 21 students. This difference in perceptions may have resulted from the physical differences in the acoustical properties of the walls in

the two classrooms. Classroom 21's exterior walls consisted of painted masonry block or plaster. Cork tack boards covered a portion of these exterior walls. Vinyl-covered wooden panels comprised the interior accordion-fold partitions. Fabric-covered acoustical panels hung on the walls over classroom 21's windows.

Conversely, the model classroom's exterior walls were composed of painted dry-wall panels. The tack boards mounted on these walls were covered with an acoustical cloth-vinyl surface. Classroom 23's interior operable walls contained an acoustical fabric covering.

Thus, the additional acoustical surfaces in the model classroom may have improved it's acoustical environment in comparison to that of the conventional CGSOC classroom. Specifically, the acoustical surfaces in each model classroom quadrant may have reflected sound well enough to facilitate students hearing their instructor. At the same time, these surfaces might have absorbed enough sound to reduce the amount of disturbance among student work groups in each quadrant.

Statement_5 (Can hear television from seat):

	Group_A	Group_B	Group_C
Agree	89%	93%	89%
Neither agree nor disagree	4%	0%	5%
Disagree	7%	7%	5%

There was no significant difference among the three groups regarding student perceptions about their ability to hear the television in their quadrant.

Survey Results: Access/Exit

Statements 16 and 36 -

(Adjacent groups enter/exit interrupts):

(Adjacent groups enter/exit disturbs):

Statement 16	Group A	Group B	Group C
Agree	81%	0%	2%
Neither agree nor disagree	11%	5%	5%
Disagree	7%	95%	93%

Statement 36	Group A	Group B	Group C
Agree	85%	2%	3%
Neither agree nor disagree	7%	5%	7%
Disagree	7%	93%	90%

In comparison to model classroom students (groups B and C), over six times the expected number of section 21 students agreed that they were disturbed by individuals entering or departing adjacent quadrants. At the same time, more than the expected number of model classroom students (groups B and C) disagreed with these statements.

Statement 35 (Enter/exit doesn't disrupt adjacent):

	Group A	Group B	Group C
Agree	59%	98%	92%
Neither agree nor disagree	15%	0%	4%
Disagree	26%	2%	4%

When compared to model classroom students (groups B and C), fewer than the expected number of section 21 students agreed that they could enter or exit their staff group area at any time without disrupting activities in adjacent staff groups. In contrast, more model classroom students (groups B and C) than expected agreed with statement 35.

Statement_41 (Enter/exit disturbs adjacent groups):

	Group_A	Group_B	Group_C
Agree	30%	0%	7%
Neither agree nor disagree	15%	0%	14%
Disagree	56%	100%	79%

In comparison to model classroom students (groups B and C), more than the expected number of section 21 students perceived that their entrance to or exit from their staff group area disturbed adjacent staff groups. Conversely, more than expected section 23 students disagreed with statement 41.

I anticipated these differences in student perceptions about their ability to enter or exit classroom quadrants without restriction because of differences in the entrances to each classroom's quadrants. More than likely, classroom 23's separate quadrant entrances permitted students to come and go with much less concern for their impact on activities in adjacent quadrants than that exhibited by section 21 students. In comparison, students in quadrants C and D of classroom 21 were unable to enter or depart their staff group area without first passing through either quadrant A or B. Hence, this situation increased the likelihood of student entrances and departures disrupting adjacent staff groups when, as often occurred, instructors in the various quadrants began and ended class break periods at different times.[10]

Survey Results: Furniture

Statement 7 (Desk space is adequate):

	Group A	Group B	Group C
Agree	29%	62%	70%
Neither agree nor disagree	4%	12%	9%
Disagree	68%	26%	21%

In comparison to model classroom students (groups B and C), more section 21 students than expected disagreed that they had adequate desk space in their classroom. In contrast, more model classroom students than expected agreed with statement 7.

These perceptions are interesting because section 21 students actually had more physical desk space per student than did model classroom students. Each student in classroom 21 had an average of nine square feet of desk space; whereas, those in classroom 23 only had six square feet of desk top. However, section 21 students shared desk space; two students sat at each eighteen square foot work table. Thus, section 21 students may have perceived their desk space as less than adequate because they were forced to share space at a work table with another student. On the other hand, model classroom students may have perceived an adequate amount of desk space because they sat at individual desks.

Students in classroom 23 also had a book shelf located under their desk tops. No such shelf was present on section 21's work tables. Students in classroom 21

stored their textbooks on the floor or on their work tables during class.[11] The presence of textbooks on work tables may have also contributed to section 21 students' perceptions that their amount of desk space was less than adequate.

Finally, instructors in classroom 21 shared space with students at work tables. Classroom 23 contained one instructor desk per quadrant. This requirement to share work table space may have influenced section 21 students' perceptions about the adequacy of their desk space.

In response to question 43, seven elective course students commented that the model classroom desks afforded them limited desk space. Thus, these elective course students, first exposed to only the large work tables in conventional classrooms, correctly perceived that the model classroom desks provided less physical desk space than did the work tables. Nevertheless, the majority of elective course students agreed with statement 7.

Statement 22 (Too much furniture):

	Group A	Group B	Group C
Agree	56%	24%	10%
Neither agree nor disagree	19%	38%	31%
Disagree	26%	38%	59%

When compared to students in classroom 23 (groups B and C), more than the expected number of section 21 students perceived that there was too much furniture in their classroom quadrant. In contrast, fewer elective

course students than expected perceived that their model classroom quadrant had too much furniture.

These differences in perceptions may have been the result of the different sizes and numbers of desks in each classroom. Sixteen individual student desks and one instructor desk per model classroom quadrant occupied a total of 102 square feet of floor space. On the other hand, eight work tables per classroom 21 quadrant occupied 144 square feet of floor space. Thus, classroom 21's work tables occupied more floor space per quadrant than did the model classroom's individual desks.

Because their work tables occupied so much floor space, section 21 students may have perceived these tables as too much furniture per quadrant. Elective course students, first exposed to only the larger work tables, might have favorably perceived the amount of furniture in the model classroom quadrants after working with the smaller individual desks.

Statement 39 (Amount of furniture is adequate):

	Group A	Group B	Group C
Agree	63%	71%	73%
Neither agree nor disagree	26%	24%	23%
Disagree	11%	5%	3%

There was no significant difference among the three groups regarding student perceptions that the amount of furniture in their classroom quadrants was adequate. The responses of elective course students complemented their

responses to statement 22. In contrast, section 21 responses to statement 39 tended to contradict their responses to statement 22. In the latter statement, a majority of section 21 students perceived too much furniture in their classroom quadrant; whereas, in the former statement, a majority perceived an adequate amount of furniture per quadrant.

Statement 14 (Chairs are comfortable):

	Group A	Group B	Group C
Agree	71%	83%	79%
Neither agree nor disagree	18%	7%	5%
Disagree	11%	10%	16%

There was no significant difference among the three groups regarding student perceptions about the comfort of classroom chairs.

However, classroom chairs were the topic of several written responses to question 43. Two elective course students recommended that the model classroom chairs be replaced. A third elective course student complained that these chairs did not fit under the individual student desks. Finally, two students in section 23 noted that the model classroom chairs were difficult to sit on.

These comments most likely were influenced by the degree of difficulty associated with adjusting the configuration of the model classroom chairs. Each chair contained three levers: one to adjust the seat height, another to adjust the seat incline, and a third to

position the back rest. Accordingly, section 23 students adjusted chair configurations almost daily. From day to day, these students were not assured of sitting in the same chair. As each staff group routinely organized into smaller work groups, students distributed furniture throughout the quadrant. Often, chairs ended up in different locations when the College's classroom services personnel placed furniture back in the standard teaching configuration following each day's classes.

Students in the term II elective were faced with an even more complex situation. These students met in classroom 23 once a week. In between these meetings, section 23 students attended required courses in the model classroom. Once again, when section 23 students moved furniture to organize for work in small groups, classroom services personnel normally returned chairs to locations different from those when elective course students last attended class in the model classroom.

Hence, model classroom students (groups B and C) may have perceived their chairs difficult to sit on because of the constant need to adjust chair configuration. Then, too, some students may not have known these chairs were adjustable or how to adjust them. For example, the student comment that the model classroom chairs did not fit under the individual student desks was only true if the chair height was adjusted above a certain

elevation. These chairs did fit under the desks when lowered to an appropriate level.

Moreover, I observed broken adjustment levers on several model classroom chairs. It appeared that individuals had used too much force when adjusting the chairs, thereby causing these levers to break. Thus, the model classroom chairs were not altogether "student-proof". In comparison, classroom 21's chairs contained no adjustable features. Aside from an occasional worn chair, classroom 21's chairs endured student use fairly well.[12]

Survey Results: Support Equipment

Statement 8 (Projection screen interferes):

	Group A	Group B	Group C
Agree	46%	60%	45%
Neither agree nor disagree	7%	10%	28%
Disagree	46%	31%	27%

In comparison to section 21, more section 23 students than expected perceived that the projection screen interfered with the use of classroom marker boards. Conversely, more section 21 students than expected disagreed that their projection screen interfered with chalkboards or tack boards in their classroom 21 quadrant.

I anticipated these differences in perceptions about projection screen interference with marker boards

or chalkboards because of the different locations of these screens in the two classrooms. The model classroom's ceiling-mounted projection screens were overhead of each quadrant's wall-mounted marker boards. When deployed, these screens covered over twenty-nine square feet of the available fifty square feet of marker board surface in each quadrant. Consequently, individuals who chose to use these marker boards in conjunction with audiovisual projections were faced with a reduced writing surface. The practical solution to this interference problem was for instructors or students to raise the projection screen to gain access to all marker board surfaces in between projecting images. Regardless, model classroom students may have negatively perceived this interference of the projection screen with the marker boards.

Classroom 21 students and instructors did not face a similar interference situation. Instead, the location of the portable projection screens in classroom 21's quadrants complemented the locations of portable chalkboards and tack boards. At worst, classroom 21's portable projection screens blocked a portion of each quadrant's wall-mounted tack boards. In contrast to model classroom students, section 21 students may not have perceived this blockage in a negative manner.

Written student comments further emphasized the model classroom's projection screen interference problem.

Four students from section 23 and four elective course students recommended that the projection screen be moved from in front of the marker boards. In addition, several faculty members, as well as the Deputy Commandant, CGSC, advised me verbally that these screens should be placed in front of each quadrant's audiovisual cabinet. From this location, they contended that instructors could project images and still use all available marker board surfaces in each quadrant.

Statement 15 (Computer supports instruction):

	Group A	Group B
Agree	37%	43%
Neither agree nor disagree	22%	10%
Disagree	41%	48%

When compared to section 21, more section 23 students than expected perceived that their computer location supported instruction within their quadrant. However, the fact that a majority of section 23 students did not agree with this statement may have indicated their inability to take full advantage of the model classroom computer capabilities.

Several section 23 students approached me individually to advocate placing the computer work station inside the audiovisual cabinet to facilitate operating the television/monitor in conjunction with the personal computer. In particular, this television/monitor served as the personal computer's screen when the two were

connected by a cable. This capability was especially beneficial for students who used the computer's graphics software to display briefing charts on the television screen during classroom presentations.

The Fort Leavenworth Media Support Center's television support division provided each classroom 23 quadrant with a six foot cable to connect the computer to the television/monitor. In each quadrant, however, the computer work station was located well over six feet from the audiovisual cabinet where the television/monitor was situated. Thus, students who used the television/monitor in conjunction with the personal computer were forced to move this work station directly in front of the audiovisual cabinet. In this location, the work station blocked student access to a significant portion of the cabinet's storage space.

Obviously, this blockage could have been prevented if the television support division had supplied a cable long enough to reach from the television/monitor to the personal computer's original location in each quadrant. Nevertheless, the students who spoke to me also complained that the computer work station occupied too much space in quadrants A and B. (These two quadrants each contained seventy-two square feet less floor space than did each of the model classroom's C and D quadrants.)

Therefore, these students argued that the best place for the computer work station was on a shelf within each quadrant's audiovisual cabinet. They contended that this location would facilitate the connection of the television/monitor to the computer as well as make available eleven more square feet of floor space in each quadrant.

Statement 18 (Can view television from seat):

	Group A	Group B	Group C
Agree	67%	90%	89%
Neither agree nor disagree	19%	2%	3%
Disagree	15%	7%	8%

In comparison to section 21, more than the expected number of model classroom students (groups B and C) perceived that they could view their quadrant's television from their seat. On the contrary, fewer than the expected number of section 21 students agreed with this statement.

I anticipated these differences in student perceptions about their ability to view televisions while seated because of the differences in the television screen sizes in the two classrooms. Television screens in model classroom quadrants were seven inches larger than the corresponding television screens in classroom 21 quadrants. Hence, it was only natural that model classroom students (groups B and C) perceived they could view their televisions more easily than did section 21 students.

Statement 23 (Sufficient marker board surface):

	Group A	Group B	Group C
Agree	52%	69%	60%
Neither agree nor disagree	11%	14%	25%
Disagree	37%	17%	15%

When compared to section 21, more than the expected number of section 23 students perceived that they had sufficient marker board surface in their model classroom quadrant. Conversely, fewer section 21 students than expected perceived that they had enough chalkboard surface in their classroom 21 quadrant.

I anticipated these differences in student perceptions regarding the sufficiency of chalkboard or marker board surfaces because of the differences between the available writing surfaces in the two classrooms. Marker boards in each classroom 23 quadrant afforded a total of fifty square feet of writing surface. On the other hand, each portable chalkboard in classroom 21's quadrants provided only forty-six square feet of writing surface; although, half this surface was out of student view at all times. Instructors rotated the chalkboard 180 degrees to expose the second half of the chalkboard writing surface.

Three elective course students recommended in writing that the amount of marker board surface per classroom 23 quadrant be increased. Perhaps these recommendations reflected their perceptions that the

projection screen interfered with the use of marker boards. Accordingly, these students may have recommended increasing the amount of writing surface per quadrant to make up for the surface blocked by the projection screen during audiovisual presentations.

Several students and faculty, in addition to the Deputy Commandant, CGSC, verbally recommended to me that a writing surface be added to the reverse side of the hinged marker boards in each classroom 23 quadrant. As designed, marker boards in each quadrant consisted of a main marker board (thirty-two square feet of writing surface) that was permanently mounted to the wall, and a hinged marker board (nine square feet of writing surface) located on either side of the main board. These hinged boards ranged in position from along the wall to a location on top of the main board.

On occasion, students and instructors closed these hinged boards on top of the main board to use the tack board surface that lay behind the hinged boards. When both hinged boards were closed accordingly, they covered eighteen square feet of main board writing surface. Because these hinged boards contained no writing surface on their reverse side, their closure on top of the main board reduced the amount of writing surface in each quadrant to only fourteen square feet. A writing surface on the reverse side of these hinged boards would ensure

the availability of a minimum of thirty-two square feet of marker board surface in each model classroom quadrant at all times.

Statement 29 (Sufficient tack board surfaces):

	Group A	Group B
Agree	52%	74%
Neither agree nor disagree	7%	5%
Disagree	41%	21%

In comparison to section 21, more section 23 students than expected perceived that they had sufficient tack board surfaces in their staff group area to mount course materials. On the contrary, fewer section 21 students than expected agreed that they had sufficient tack board surfaces in their classroom 21 quadrants.

I anticipated these differences in student perceptions regarding available tack board surface because of the differences between the tack boards in the two classrooms. Each classroom's quadrants had a relatively equal amount of wall-mounted tack board surface. However, major differences existed between the amount of tackable surface which the portable tack boards provided classroom 21 quadrants and that which the interior operable walls provided classroom 23 quadrants. Two portable tack boards per classroom 21 quadrant consisted of 160 square feet of tackable surface. Similar to the writing surface on the portable chalkboards, only half of the tackable surface per tack board was in student view at a time. Students

had to turn the tack board around to expose the opposite side's tackable surface.

Conversely, the model classroom's interior operable walls provided 376 square feet of tackable surface to each section 23 staff group. Moreover, this entire surface was available for use by each staff group as long as the operable walls separated quadrants.

Statement 38 (Tack boards are easy to use):

	Group A	Group B
Agree	59%	33%
Neither agree nor disagree	15%	7%
Disagree	26%	60%

When compared to section 21, more than the expected number of section 23 students disagreed that they could easily tack charts and maps to their quadrant's tack boards. In contrast, more section 21 students than expected perceived that they could easily tack materials to their portable tack boards.

These differences in student perceptions regarding the ease of using the tack boards in the two classrooms most probably resulted from the material differences between the portable tack boards and the interior operable walls. (Wall-mounted tack boards in both classrooms afforded a tackable surface into which students easily mounted push pins or flat tacks by hand.)[13] Classroom 21's portable tack boards consisted of a painted cork surface. Section 21 students easily mounted their charts

and maps to these boards using push pins or flat tacks.[14]

On the contrary, the surface on the model classroom's operable walls consisted of fabric-covered press board. Section 23 students found it next to impossible to place push pins or tacks into this surface by hand. Instead, selected students brought personal hammers to their staff groups for use in pounding push pins or nails into the operable walls. Although these hammers were effective in tacking materials to the operable walls, their use also proved inefficient. Student work groups often wasted time while they waited their turn to use the staff group hammer.[15]

The tackable surface on the model classroom's operable walls was also the subject of seven written comments by section 23 students. These students complained that the operable wall surfaces really were not tackable. They recommended placing a surface on these walls which would permit students to mount push pins and tacks by hand.

Statement_33 (Enough electrical outlets):

	Group_A	Group_B	Group_C
Agree	30%	98%	50%
Neither agree nor disagree	7%	0%	48%
Disagree	63%	2%	2%

In contrast to section 21, almost twice the expected number of section 23 students perceived that

there were enough electrical outlets in their model classroom quadrant to power equipment during instruction. In comparison, more than six times the expected number of section 21 students disagreed that they had enough electrical outlets in their classroom 21 quadrant to power equipment used in instruction.

Statement 42 (Electrical outlets where needed):

	Group A	Group B	Group C
Agree	33%	97%	50%
Neither agree nor disagree	19%	0%	47%
Disagree	48%	3%	3%

When compared to section 21, more than the expected number of section 23 students perceived that electrical outlets were located where needed to power audiovisual and computer equipment during instruction. Conversely, more than the expected number of section 21 students disagreed that electrical outlets were situated where required to power instructional equipment within their quadrant.

I anticipated these differences in student perceptions about the availability of electrical support because of differences in the number of electrical outlets in each classroom. Including wall receptacles, each model classroom quadrant contained forty-four individual electrical outlets. Forty of these outlets were dispersed throughout each quadrant's floor-mounted multi-purpose units: four electrical outlets per unit. Hence, section 23 students had the flexibility to operate audiovisual or

computer equipment from virtually anywhere within their model classroom quadrant.

Instead, classroom 21's electrical outlets were limited to one or two duplex receptacles per quadrant. At best, a section 21 staff group had access to four individual electrical outlets. These outlets powered all audiovisual and computer equipment used in section 21 staff groups. By necessity, students and faculty located this equipment close to these outlets, thereby constraining their flexibility to employ this equipment throughout the staff group area.

Survey Results: Space

Statement 10 (Feel confined in staff group area):

	Group A	Group B	Group C
Agree	61%	26%	26%
Neither agree nor disagree	4%	31%	21%
Disagree	36%	43%	53%

In comparison to model classroom students (groups B and C), twice the expected number of section 21 students perceived their staff group area as confining. Among elective course students, fewer than expected perceived their model classroom quadrant as confining.

Statement 31 (Enough individual space):

	Group A	Group B	Group C
Agree	30%	55%	64%
Neither agree nor disagree	11%	10%	12%
Disagree	59%	36%	23%

Once again, a comparison of the three groups revealed that twice the expected number of section 21

students perceived they did not have enough individual space in their classroom 21 quadrant. Elective course students' responses to this statement supported their responses to statement 10: more elective course students than expected perceived enough individual space in their model classroom quadrant.

At first glance, the empirical data did not confirm the perceptions demonstrated in student responses to statements 10 and 31. Classroom 23's quadrants averaged 611 square feet of gross floor space; whereas, the average gross floor space per classroom 21 quadrant was 648 square feet. However, students were not free to walk around in all of this gross floor space. Each quadrant in classroom 21 contained one portable chalkboard (which occupied sixteen square feet of floor space), two portable tack boards (twenty-eight square feet), a television cart (five square feet), a portable projection screen (eighteen and one-half square feet), a computer work station (eleven square feet), an overhead projector table (six square feet), and eight work tables with seventeen chairs (144 square feet).

Because the model classroom had tack boards, a projection screen, and marker boards mounted on its walls, it required less portable support equipment than did classroom 21. Classroom 23 quadrants contained a computer

work station (eleven square feet), an overhead projection cart (three square feet), and seventeen individual desks with chairs (102 square feet). Televisions in the model classroom sat in the audiovisual cabinets which were recessed in the quadrant walls.

Accounting for the floor space occupied by furniture and support equipment in classrooms 21 and 23 yielded the following average net floor space in which students were free to walk around:

Classroom 21 - 419 net square feet per quadrant.

Classroom 23 - 495 net square feet per quadrant.

These revised totals confirmed the student perceptions demonstrated in the responses to statements 10 and 31. Also of note was the fact that both these areas exceeded the twenty net square feet of space per student required by the U.S. Army Service Schools Design Guide for instruction in staff groups:[16]

Classroom 21 - 26 net square feet per student.

Classroom 23 - 31 net square feet per student.

Seven elective course students commented in writing that they felt cramped in their model classroom quadrants. In general, these students recommended more space per quadrant. These recommendations might have reflected differences in these students' perceptions about the two classrooms' average <u>gross</u> floor space as opposed to average <u>net</u> floor space.

Statements 25 and 40 -

(Enough space to store books and supplies):

(Storage space is adequate):

Statement 25	Group A	Group B
Agree	26%	48%
Neither agree nor disagree	0%	12%
Disagree	74%	40%

Statement 40	Group A	Group B
Agree	26%	45%
Neither agree nor disagree	11%	10%
Disagree	63%	45%

When compared to section 23, fewer section 21 students than expected perceived that they had enough storage space in their classroom 21 quadrant. Among section 23 students, more than expected perceived that their model classroom quadrant had adequate space to store reference books and office supplies in their classroom quadrant.

The empirical data confirmed these perceptions. Aside from portable storage chests which some students brought to their classroom 21 quadrants, section 21 had no designated storage space for reference textbooks and had only limited classroom material storage space: a small shelf on the wall of each quadrant.

In contrast, each model classroom quadrant had a combined audiovisual equipment/classroom material storage cabinet recessed in the wall. Each cabinet contained over thirty-eight square feet of shelf space. Even with a

television monitor, two speakers, two video cassette players, and a 35mm slide projector stored in each cabinet, seventeen square feet of shelf space remained per cabinet. This remaining space is what students in each section 23 staff group used to store school supplies, reference textbooks, and instructional materials.

Still, slightly less than a majority of section 23 students agreed that this cabinet storage space was adequate. This agreement percentage may have indicated that seventeen square feet of shelf space was not sufficient to store all the classroom materials which CGSOC students required.

Survey Results: Flexibility

Statement 30 (Can easily open interior walls):

	Group A	Group B
Agree	67%	45%
Neither agree nor disagree	26%	17%
Disagree	7%	38%

More section 21 students than expected perceived that they could rapidly open their partition walls in comparison to section 23 students. On the contrary, more than the expected number of section 23 students disagreed that they could rapidly open their operable walls.

I anticipated these differences in perceptions about the ease of opening interior walls because of the different nature of classroom 21's partitions and classroom 23's operable walls. The accordion-fold

partitions weighed less and were less bulky than classroom 23's operable wall sections. In addition, students only had to open four partition sections to prepare classroom 21 for large group instruction. In contrast, section 23 students had to move a total of twenty-five, four-foot-wide operable wall sections to prepare their classroom for instruction of a large group. Although these wall sections weighed nearly 400 pounds each, students moved them with relative ease along an overhead track suspension system. Students in section 23 required more time to open their operable wall sections -- approximately fifteen minutes -- than section 21 students required to open their partitions (from one to two minutes.)[17]

Yet, students in either classroom seldom were required to open the operable wall sections or the partitions during class periods. For the most part, students opened these interior walls during fifteen minute breaks between periods of instruction. As a consequence, the time required to open interior walls never really impeded student learning in either classroom.[18]

Finally, the Deputy Commandant, CGSC, echoed to me a comment made by section 23's student leader regarding his ability to make verbal announcements throughout classroom 23. The student leader complained that when the model classroom's operable walls separated the staff

groups, he was forced to visit each staff group area individually to make his routine announcements. He recommended to the Deputy Commandant that some form of swing door be placed where the operable wall sections meet in the center of the room. With this swing door, he visualized the capability to simultaneously announce to all four staff groups in the model classroom.

I must note that, by design, these operable wall sections already contain two doors: one between quadrants A and D and another between quadrants B and C. Thus, the student leader already had the capability to announce to half of section 23's students at the same time.

Statement 9 (Can easily rearrange furniture):

	Group A	Group B
Agree	54%	76%
Neither agree nor disagree	4%	12%
Disagree	43%	12%

In comparison to section 21, more section 23 students than expected perceived that they could easily rearrange their classroom furniture to support various types of instruction. In contrast, more section 21 students than expected disagreed that they could easily rearrange their furniture.

Most probably, differences in desk size and chair type between the two classrooms contributed to these differences in perception. Classroom 23's individual student desks were smaller than the two-man work tables in

classroom 21. As a result, one student could easily reposition classroom 23's desks; whereas, normally two students repositioned classroom 21's work tables. Additionally, the casters on classroom 23's chairs made it easy for students in section 23 to roll chairs to needed locations in the model classroom. Classroom 21's straight-legged chairs had no casters. Thus, students dragged or carried these chairs into place, as needed.

Statement 17 (Can easily close interior walls):

	Group A	Group B
Agree	30%	45%
Neither agree nor disagree	7%	21%
Disagree	63%	33%

There was no significant difference among student perceptions in sections 21 and 23 about the ease of closing classroom 21's partitions or classroom 23's operable walls, respectively. However, more than the expected number of section 21 students disagreed that the partitions were easy to close. Conversely, more than the expected number of section 23 students agreed that the operable walls were easy to close.

These results, although not statistically significant, may have indicated differences in student perceptions about their ability to secure classroom 21's partitions and classroom 23's operable walls. Specifically, the latches that held classroom 21's partitions together in the center of the room were

difficult to operate. In contrast, latches did not secure classroom 23's operable walls in the center of the room. Instead, these operable walls merely butted against one another, forming an acoustical seal.

Survey Results: Student Comments

Within my analyses of the responses to the forty survey statements, I summarized pertinent student written recommendations to make the CGSOC physical environment more conducive for learning. Aside from these recommendations, I received two additional types of comments in response to question 43. First, seven elective course students commented that the physical learning environment of the model classroom did not justify its cost. Secondly, I received positive comments about the model classroom's interior design from both section 23 and elective course students.

Forty elective course students praised the model classroom's physical learning environment. In fact, ten of these students also advocated renovating the remaining CGSOC classrooms in a manner similar to the model classroom's interior design. Three section 23 students also praised their physical learning environment.

In comparison to section 23's sample size, (one-fourth that of the elective course), a proportionally larger number of elective course students praised the

model classroom design. I anticipated just such an occurrence because of the timing of the two surveys. By design, I surveyed section 23's students during term I when they were familiar with only the model classroom's physical learning environment. At the time of this survey, section 23 students did not know enough about conventional CGSOC physical learning environments to make a valid comparison between classroom 23 and others.

In contrast, elective course students came to classroom 23 in term II after having experienced only CGSOC's conventional classrooms during term I. Once they experienced the model classroom's physical learning environment, they were capable of assessing which type of classroom was more conducive to learning. Consequently, the greater number of written praises from this group probably indicated the positive effect that the model classroom's interior design had on their perceptions of their physical learning environment.

Survey Results: Location Chart

By including the location chart in my survey, I had hoped to determine differences in student perceptions about selected aspects of the two classrooms' physical learning environments. For example, I expected section 21 students to indicate locations on the chart which were far away from their quadrant's accordion-fold partitions as

places where they perceived the least amount of noise interference. Conversely, I expected that proximity to the model classroom's operable walls would not influence section 23 students when they selected locations where they perceived minimum noise interference.

Instead, student responses on these charts revealed no identifiable pattern for any of the five evaluated aspects of physical learning environment. Furthermore, the limited number of completed charts that I received hindered my analysis. During term I survey, I received thirty-seven completed charts; however, twelve charts contained no classroom identification. Hence, these twelve charts were of no use in my analysis. Of the remaining twenty-five charts, students incorrectly completed five charts. That left twenty charts to analyze: four from section 21 and sixteen from section 23. After reviewing these remaining charts, I was unable to draw any conclusions from student entries regarding the selected aspects of the two classrooms' physical learning environments. As a consequence, I decided to eliminate this chart from the term II survey.

ENDNOTES, CHAPTER 4

1
Eighteen group C students were members of section 23. Therefore, I eliminated their responses from the term II survey results.

2
Respondents returned twelve more classroom charts than I indicated in Table 5. However, these twelve charts contained no identification of section or staff group. As a result, I was unable to use these charts in my analysis.

3
From author interview with Major Peter R. Eliason, Plans and Operations Division, Directorate of Academic Operations, U.S. Army Command and General Staff College on 7, 23, and 31 January 1991.

4
Ibid., on 2 April 1991.

5
Author observation.

6
U.S. Department of the Army, Design Guide 1110-3-106: Department of the Army Design Guide for U.S. Army Service Schools (Washington, D.C.: Government Printing Office, May 1986), 3-10, 4-51.

7
Ibid.

8
Ibid., 4-49.

9
Ibid, 3-5.

10
Author observation.

11
Ibid.

12
Ibid.

13
Ibid.

14 Ibid.

15 Ibid.

16 U.S. Department of the Army, _Design Guide 1110-3-106: Department of the Army Design Guide for U.S. Army Service Schools_, 4-47.

17 Author observation.

18 Ibid.

19 Ibid.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

My analysis of the data led to three answers for my research question:

> Would the model classroom's interior design improvements enhance student perceptions about their physical learning environment?

First, the following aspects of the model classroom's interior design significantly enhanced model classroom student perceptions about the CGSOC physical learning environment in comparison to the control group:

- Available light to read textbooks.
- Acoustical separation among staff groups.
- Acoustical properties within each staff group.
- Separate entrance to each staff group area.
- Individual student desks.
- Available tack board surface.
- Location and quantity of electrical outlets.
- Television screen size.

Next, several aspects of the model classroom's interior design made a relatively minor improvement in the perceptions of model classroom students about their physical learning environment in comparison to those of the control group:

Ability to prevent window light interference with audiovisual presentations.

Ability to dim classroom lighting during audiovisual presentations.

Available space per student.

Storage space for reference textbooks and classroom materials.

Ease of rearranging classroom furniture.

Available marker board surface.

Third, these aspects of the model classroom's interior design effected little or no improvement in the perceptions of model classroom students about their physical learning environment in comparison to those of the control group:

Available light to read marker and tack boards.

Ability to prevent sunlight glare on marker and tack boards.

Amount of furniture per staff group area.

Chair comfort.

Computer location.

Projection screen location.

Ease of use of tack boards on interior operable walls.

Ease of opening or closing interior operable walls.

Moreover, the operational failure of classroom 23's heating, ventilation, and air conditioning system (HVAC) prevented me from determining the effect of the model classroom's climate control system on student perceptions about their physical learning environment. However, student responses to survey statements regarding climate control did demonstrate the importance of acceptable environmental conditions toward enhancing student perceptions about the physical learning environment in CGSOC classrooms.

Recommendations

It follows, then, that designers should consider the following recommendations to enhance the CGSOC physical learning environment when they prepare drawings and specifications for a contract to renovate the CGSOC classrooms:

Climate Control. Provide classrooms with an HVAC system that can establish and maintain the environmental conditions specified in the U.S. Army Service Schools Design Guide for instruction in staff groups[1] -

Heating season - Sixty-eight degrees Fahrenheit.

Cooling season - Seventy-eight degrees Fahrenheit.

Relative humidity - From thirty to seventy percent.

Controls - Separate temperature controls for each staff group area.

Thereupon, survey students about their classroom climate control system to accomplish what I was unable to do in my study: determine the effect of a system of independent HVAC controls on student perceptions about their physical learning environment.

Lighting. Install sufficient indirect fluorescent lighting fixtures per quadrant to supply the seventy footcandles of light specified in the U.S. Army Service Schools Design Guide to support all educational tasks.[2] In the model classroom, this lighting level was attained by illuminating the indirect fluorescent lights in conjunction with the incandescent spot lights. However, the common method to illuminate each model classroom quadrant was by indirect fluorescent lights alone. These lights failed to produce the requisite seventy footcandles of light specified in the design guide.

Additionally, the lighting system in each staff group area should support the design guide requirement for thirty footcandles of light during audiovisual presentations.[3] Whether this system consists of fluorescent lighting alone or a combination of fluorescent

and incandescent lighting is probably not important. Instead, lighting controls must permit the reduction of light intensity per quadrant to thirty footcandles during audiovisual presentations.

Provide some form of operable opaque blinds to cover windows during audiovisual presentations. The model classroom's hinged marker boards effectively provided this capability.

Acoustics. Provide acoustical separation among staff group areas similar to that provided by the model classroom's interior operable walls.

Provide acoustical properties within staff group areas similar to those provided by the acoustical surfaces in each model classroom quadrant.

Access/Exit. Provide separate entrances to each staff group area.

Furniture. Provide individual desks similar to those in the model classroom.

Provide chairs (on casters) that possess fewer adjustable controls than do the model classroom chairs. At most, these chairs should contain adjustments for back rest and seat height. Ensure that adjustment levers are durable enough to withstand daily use, nine to ten months out of the year.

Provide eighteen desks and chairs per staff group area to accommodate sixteen CGSOC students plus two

instructors. Since several courses are taught in a team-teaching format, staff group areas need desks and chairs for two instructors. Additionally, provide one or two visitor chairs per staff group area as well as a chair for each computer work station.

Support Equipment. Provide one television/monitor, with twenty-six inch screen, per quadrant. Televison/monitor should be capable of serving as a screen for the quadrant's personal computer.

Provide a cord long enough to connect each television/monitor to its corresponding personal computer without having to move the computer work station. Consider including the computer work station in the design of an expanded audiovisual equipment/classroom material storage cabinet for each quadrant.

Provide fewer electrical outlets in each floor-mounted multi-purpose unit than were provided in the model classroom units. At most, students and instructors used two outlets (one duplex receptacle) per multi-purpose unit.[4]

Consider installing fewer telephone jacks and fewer computer connections (local area network) than the number provided in each model classroom quadrant. Telephone jacks were never utilized during CGSOC instruction. One local area network connection per quadrant was employed to

connect each quadrant's personal computer to the College's network.[5]

Ceiling-mount each quadrant's projection screen in front of the audiovisual equipment/classroom material storage cabinet. At the same time, eliminate any incandescent spot lights or direct fluorescent lighting in the ceiling near this projection screen to prevent interference with audiovisual presentations.

Provide a tackable surface on the interior operable walls. For this surface, choose a material which permits students to mount push pins and flat tacks by hand. If no such surface is available for interior operable walls, consider mounting a more tackable surface on top of the operable wall surface.

Space. Provide at least the same amount of available space per student as currently exists in each model classroom quadrant.

Provide at least the same amount of storage space (audiovisual equipment and classroom material) per staff group area as currently exists in each model classroom quadrant. Still, slightly fewer than fifty percent of section 23 students agreed that they had sufficient storage space in their model classroom staff group area. Therefore, consider increasing the amount of storage space per quadrant.

If cabinets similar to those in the model classroom are designed, there are two easy ways to increase storage space for students. One is to add a shelf to the center, bottom storage compartment. As currently designed for the model classroom, this twenty-eight inch high compartment has no shelf. Second, reduce the width of the center audiovisual equipment compartments and increase the width of the adjacent classroom material storage compartments. The widest piece of audiovisual equipment stored in the center compartments was the television: twenty-six inches. The center compartments, however, were over thirty-six inches wide. Hence, students could not use over ten inches of shelf space in these center audiovisual equipment compartments.

Mount tack boards on each quadrant's exterior walls to augment the tackable surface on the interior operable walls and to preserve available floor space within staff group areas.

Wall-mount marker boards on an exterior wall in each quadrant. Provide at least as much marker board writing surface as was provided to each model classroom quadrant. If hinged boards are used, finish these boards on both sides with a usable writing surface.

Flexibility. Outfit classrooms with furniture that students can easily move throughout their staff group area.

Use an operable interior wall to separate classrooms into staff group areas.

ENDNOTES, CHAPTER 5

[1] U.S. Department of the Army, Design Guide 1110-3-106: Department of the Army Design Guide for U.S. Army Service Schools (Washington, D.C.: Government Printing Office, May 1986), 4-51.

[2] Ibid., 3-6.

[3] Ibid., 3-5.

[4] Author observation.

[5] Ibid.

APPENDIX I

The memorandum on which the CGSOC Class Director approved my student assignment in academic year 1990 - 1991 to section 23: the model classroom.

P&O
[illegible]

ATZL-SWG-P (340f)

29 JAN 90

MEMORANDUM FOR CLASS DIRECTOR

SUBJECT: Student Assignment for AY 90-91 CGSOC

1. Request you assign CPT Douglas Maurer, 182-46-8580, to a student staff group in classroom 23 during AY 90-91 CGSOC.

2. CPT Maurer is the DAO project officer for the CGSOC expansion. As part of this expansion, we are building a state-of-the-art teaching facility in classroom 23. This classroom will serve as a model for the design of classrooms in the General Instruction Building (GIB). Further, it is a model for renovating the remaining CGSOC classrooms following completion of the GIB.

3. CPT Maurer will evaluate the model classroom design for us while he is a student in next year's CGSOC. Consequently, he can best perform this evaluation if you assign him to a staff group in classroom 23. He has already been slated to attend next year's course.

4. Point of contact for further information is LTC Piraneo, 3409.

LEWIS I. JEFFRIES
Colonel, Field Artillery
Director, Academic Operations

ATZL-SWG 1st End /yn/2750

Class Director, USACGSC, Ft Leavenworth, KS 66027-6920 30 Jan 90

FOR Dir, Academic Operations, USACGSC, Ft Leavenworth, KS 66027-6900

Done.

J. A. SAVITTIERE, JR.
COL, MI
Class Director

APPENDIX II

The basis for my survey to collect student perceptions about the physical learning environment in the model classroom and in a conventional classroom: forty statements, one question, and a chart.

Statements are grouped by the applicable aspect of the CGSOC classroom interior design: climate control, lighting, acoustics, furniture, access/exit, support equipment, space, or flexibility.

Climate Control

The air is stagnant in my staff group area.

When it is warm outside, I feel comfortable in my staff group area.

When the heat is on, the air is too dry for me in my staff group area.

The air conditioning in my staff group area is adequate during warm weather.

On humid days outdoors, the air is too humid for me in my staff group area.

During cold weather, I feel comfortable in my staff group area.

Lighting

There is enough light in my staff group area for me to read my textbooks and notes.

Light coming through the windows in my staff group area makes it difficult for me to see audiovisual presentations.

Sunlight from my staff group area's windows creates glare on the chalkboards or marker boards and prevents me from reading them.

Lighting in my staff group area can be dimmed to enhance audiovisual presentations, while still providing me enough light to read my notes or textbooks.

Lighting in my staff group area permits me to view the chalkboards or marker boards and the tack boards from my seat.

Acoustics

When seated at my desk, I can hear the television in my staff group area.

Noise from students at other table work groups in my staff group area prevents me from concentrating on what I'm doing.

Noise from adjacent staff group areas interferes with my concentration.

I can hear what goes on in adjacent staff group areas.

My classroom's partition walls create a work space for my staff group members which is free of disturbances from adjacent staff group areas.

I can hear my instructor from anywhere in my staff group area.

Access/Exit

When students in adjacent staff group areas enter or depart the classroom, they interrupt my staff group's activities.

I can enter or leave my staff group area at any time without disrupting what's going on in adjacent staff group areas.

Students entering or departing other staff group areas disturb my concentration.

When I enter or leave my staff group area, I disturb the activities of adjacent staff groups.

Furniture

I have adequate desk space in my staff group area.

The chairs in my staff group area are comfortable.

There is too much furniture in my staff group area.

There is an adequate amount of furniture in my staff group area to support instruction.

Support Equipment

The projection screen in my staff group area interferes with the use of tack boards, marker boards, or chalkboards.

The computer work station in my staff group area is well located to support instruction.

There are sufficient chalkboard or marker board surfaces in my staff group area.

There are sufficient tack board surfaces in my staff group area to mount course work materials.

There are enough electrical outlets in my staff group area for the electrical equipment used in instruction.

It is easy for me to tack charts and maps to the tack boards in my staff group area.

I can view the television in my staff group area without moving from my seat.

Electrical outlets in my staff group area are located where needed to power audiovisual and computer equipment during instruction.

Space

I feel confined by the physical surroundings of my staff group area.

There is enough space in my staff group area for my staff group members to store needed reference books and office supplies.

I have enough individual space in my staff group area.

Storage space in my staff group area is adequate.

Flexibility

My staff group members can easily rearrange the furniture in my staff group area to support various types of instruction.

My staff group members can easily close my classroom's partition walls.

My staff group members can rapidly open my classroom's partition walls to support large group instruction.

General

What can the Command and General Staff College do to make the physical environment in your staff group area more conducive to learning?

Chart

For each of the conditions listed below, place the corresponding number at the location in your staff group area where you would feel most comfortable.

(Example: Near a door for quick exit - 1)

Most consistent light for both reading and viewing audiovisual presentations - 2

Least amount of noise interference - 3

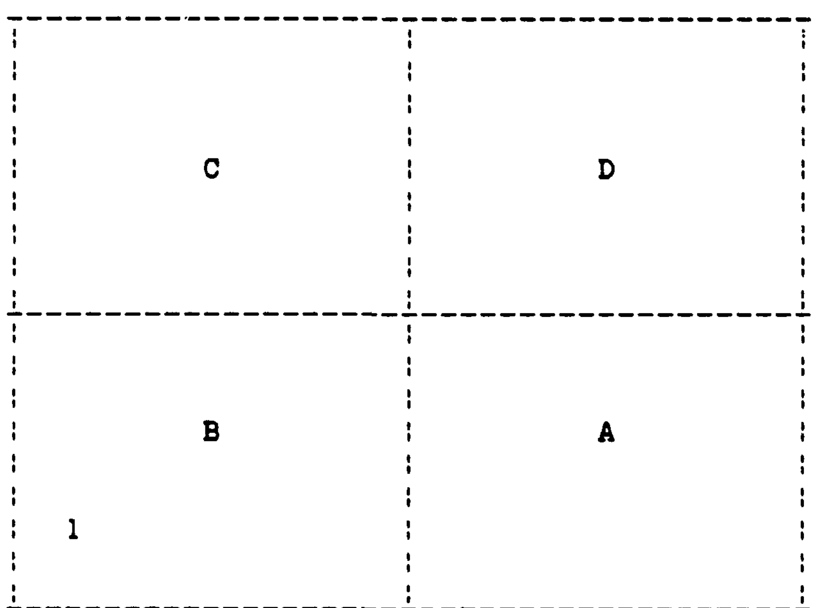
Easiest access to my seat - 4

When air conditioning is on - 5

When heating is on - 6

MY CLASSROOM NUMBER ________

WINDOW



HALLWAY

APPENDIX III

The memorandum on which Dr. Ernest Lowden, Chief, Evaluation and Standardization Division, approved my survey and assigned a survey control number.

ATZL-SWP 4 December 1990

MEMORANDUM THRU

LTC Charles Firanec, MMAS Committee Chair, DAO

DSDP

Class Director

FOR DAO, Attn: OES

SUBJECT: Request for Approval of CGSOC Student Survey

1. Request approval to survey CGSOC students in classrooms 21 and 23 with the attached questionnaire. I also enclosed the survey instruction memorandum for your review.

2. I developed this questionnaire in consultation with Mr. Dave Kent, Office of Evaluation and Standardization.

3. The survey results will provide data for my MMAS research regarding the effect of interior design improvements on the quality of learning for CGSOC students. In particular, I hope to use these data to validate the CGSOC model classroom design.

4. During the week of 10 December 1990, I'll survey 45 CGSOC students whom I select at random from classroom 21 and from classroom 23. In term II, I also want to survey students attending elective courses in classroom 23.

Enclosures

Douglas Maurer

DOUGLAS MAURER
MAJ, EN
CGSOC Staff Group 23C

To: Maj Maurer
approved - Control # 9136-002

APPENDIX IV

The survey which I administered on 10 December 1990 to forty-five students selected at random from sections 21 and 23.

SURVEY CONTROL NUMBER: 9136-002

ATZL-SWG

10 December 1990

MEMORANDUM FOR Selected CGSOC Students in Classrooms 21 and 23

SUBJECT: Student Survey

1. Please complete the attached survey and return it to your section's student survey representative NLT 18 DECEMBER 1990. Your responses are confidential; do not place your name or student number on your written comments or on the attached answer sheet.

2. Background.

a. You were selected at random to participate in this survey regarding CGSOC student perceptions about the learning environment in Bell Hall classrooms.

b. This survey is part of a TRADOC initiative to determine the relationship between physical training environments and training effectiveness. Specifically, your survey responses will assist the Command and General Staff College in designing the future renovation of CGSOC classrooms.

3. Thank you for your cooperation.

Enclosures

DOUGLAS MAURER
MAJ, EN
CGSOC Staff Group 23C

SURVEY CONTROL NUMBER: 9136-002

Use a NUMBER 2 PENCIL to record your responses on the answer sheet.

1. I am in: A - classroom 21.
-or-
B - classroom 23.

2. I am in staff group: A B C D (Complete appropriate response on answer sheet.)

Use the following scale for questions 3 through 42:

A = Strongly Agree
B = Agree
C = Neither Agree nor Disagree
D = Disagree
E = Strongly Disagree

3. The air is stagnant in my staff group area.

4. There is enough light in my staff group area for me to read my textbooks and notes.

5. When seated at my desk, I can hear the television in my staff group area.

6. Noise from students at other table work groups in my staff group area prevents me from concentrating on what I'm doing.

7. I have adequate desk space in my staff group area.

8. The projection screen in my staff group area interferes with the use of tack boards, marker boards, or chalkboards.

9. My staff group members can easily rearrange the furniture in my staff group area to support various types of instruction.

10. I feel confined by the physical surroundings of my staff group area.

11. When it is warm outside, I feel comfortable in my staff group area.

A = Strongly Agree
B = Agree
C = Neither Agree nor Disagree
D = Disagree
E = Strongly Disagree

12. Light coming through the windows in my staff group area makes it difficult for me to see audiovisual presentations.

13. Noise from adjacent staff group areas interferes with my concentration.

14. The chairs in my staff group area are comfortable.

15. The computer work station in my staff group area is well located to support instruction.

16. When students in adjacent staff group areas enter or depart the classroom, they interrupt my staff group's activities.

17. My staff group members can easily close my classroom's partition walls.

18. I can view the television in my staff group area without moving from my seat.

19. When the heat is on, the air is too dry for me in my staff group area.

20. Sunlight from my staff group area's windows creates glare on the chalkboards or marker boards and prevents me from reading them.

21. I can hear what goes on in adjacent staff group areas.

22. There is too much furniture in my staff group area.

23. There are sufficient chalkboard or marker board surfaces in my staff group area.

24. My classroom's partition walls create a work space for my staff group members which is free of disturbances from adjacent staff group areas.

A = Strongly Agree
B = Agree
C = Neither Agree nor Disagree
D = Disagree
E = Strongly Disagree

25. There is enough space in my staff group area for my staff group members to store needed reference books and office supplies.

26. The air conditioning in my staff group area is adequate during warm weather.

27. Lighting in my staff group area can be dimmed to enhance audiovisual presentations, while still providing me enough light to read my notes or textbooks.

28. I can hear my instructor from anywhere in my staff group area.

29. There are sufficient tack board surfaces in my staff group area to mount course work materials.

30. My staff group members can rapidly open my classroom's partition walls to support large group instruction.

31. I have enough individual space in my staff group area.

32. On humid days outdoors, the air is too humid for me in my staff group area.

33. There are enough electrical outlets in my staff group area for the electrical equipment used in instruction.

34. Lighting in my staff group area permits me to view the chalkboards or marker boards and the tack boards from my seat.

35. I can enter or leave my staff group area at any time without disrupting what's going on in adjacent staff group areas.

36. Students entering or departing other staff group areas disturb my concentration.

A = Strongly Agree
B = Agree
C = Neither Agree nor Disagree
D = Disagree
E = Strongly Disagree

37. During cold weather, I feel comfortable in my staff group area.

38. It is easy for me to tack charts and maps to the tack boards in my staff group area.

39. There is an adequate amount of furniture in my staff group area to support instruction.

40. Storage space in my staff group area is adequate.

41. When I enter or leave my staff group area, I disturb the activities of adjacent staff groups.

42. Electrical outlets in my staff group area are located where needed to power audiovisual and computer equipment during instruction.

Please write your response to question 43 in the space remaining on this page. Use the back, if needed.

43. What can the Command and General Staff College do to make the physical environment in your staff group area more conducive to learning?

44. For each of the conditions listed below, place the corresponding number at the location in your staff group area where you would feel most comfortable.

(Example: Near a door for quick exit - 1)

Most consistent light for both reading and viewing audiovisual presentations - 2

Least amount of noise interference - 3

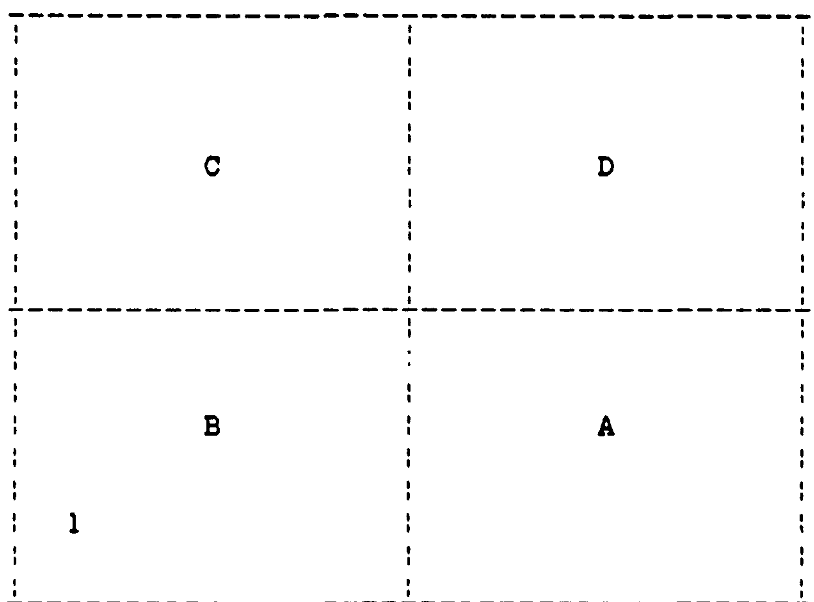
Easiest access to my seat - 4

When air conditioning is on - 5

When heating is on - 6

MY CLASSROOM NUMBER ________

WINDOW



HALLWAY

APPENDIX V

The survey which I administered from 11 to 14 February 1990 to 180 students selected at random from the term II elective, A451, Logistics for Commanders.

NOTE: "Leave Blank" entries correspond to statements which I eliminated from the term II survey. For the this survey, I used the same numbering system that I had used for the December survey. As a result, I facilitated the creation of one data file from the December and February survey results. When the computer scanned the mark sense data cards, it stored responses from either survey under corresponding statement numbers.

SURVEY CONTROL NUMBER: 9136-002

ATZL-SWG

10 February 1991

MEMORANDUM FOR Selected CGSOC students attending A451, Logistics for Commanders

SUBJECT: Student Survey

1. Please complete the attached survey. Your responses are confidential; do not place your name or student number on your written comments or on the attached answer sheet.

2. Background.

a. You were selected at random to participate in this survey regarding CGSOC student perceptions about the learning environment in classroom 23.

b. This survey is part of a TRADOC initiative to determine the relationship between physical training environments and training effectiveness. Specifically, your survey responses will assist the Command and General Staff College in designing the future renovation of CGSOC classrooms.

3. Thank you for your cooperation.

Enclosures

DOUGLAS MAURER
MAJ, EN
CGSOC Staff Group 23C

SURVEY CONTROL NUMBER: 9136-002

Use a NUMBER 2 PENCIL to record your
responses on the answer sheet.

1. My CGSOC section is: A - 23
B - Do not use.
C - Other than section 23.

2. I attend A451 in quadrant: A - 23A
B - 23B
C - 23C
D - 23D

Use the following scale for questions 3 through 42:

A = Strongly Agree
B = Agree
C = Neither Agree nor Disagree
D = Disagree
E = Strongly Disagree

3. The air is stagnant in my A451 quadrant.

4. There is enough light in my A451 quadrant for me to read my textbooks and notes.

5. When seated at my desk, I can hear the television in my A451 quadrant.

6. Leave Blank.

7. I have adequate desk space in my A451 quadrant.

8. The projection screen in my A451 quadrant interferes with the use of marker boards.

9. Leave Blank.

10. I feel confined by the physical surroundings of my A451 quadrant.

11. Leave Blank.

12. Light coming through the windows in my A451 quadrant makes it difficult for me to see audiovisual presentations.

A = Strongly Agree
B = Agree
C = Neither Agree nor Disagree
D = Disagree
E = Strongly Disagree

13. Noise from adjacent quadrants in classroom 23 interferes with my concentration.

14. The chairs in my A451 quadrant are comfortable.

15. Leave Blank.

16. When students in adjacent quadrants enter or depart classroom 23, they interrupt activities in my A451 quadrant.

17. Leave Blank.

18. I can view the television in my A451 quadrant without moving from my seat.

19. When the heat is on, the air is too dry for me in my A451 quadrant.

20. Sunlight from my A451 quadrant's windows creates glare on marker boards and prevents me from reading them.

21. I can hear what goes on in adjacent quadrants in classroom 23.

22. There is too much furniture in my A451 quadrant.

23. There are sufficient marker board surfaces in my A451 quadrant.

24. Classroom 23's partition walls create a work space in my A451 quadrant which is free of disturbances from adjacent quadrants.

25. Leave Blank.

26. Leave Blank.

27. Lighting in my A451 quadrant can be dimmed to enhance audiovisual presentations, while still providing me enough light to read my notes or textbooks.

A = Strongly Agree
B = Agree
C = Neither Agree nor Disagree
D = Disagree
E = Strongly Disagree

28. I can hear my instructor from anywhere in my A451 quadrant.

29. Leave Blank.

30. Leave Blank.

31. I have enough individual space in my A451 quadrant.

32. Leave Blank.

33. There are enough electrical outlets in my A451 quadrant for the electrical equipment used in instruction.

34. Lighting in my A451 quadrant permits me to view the marker boards from my seat.

35. I can enter or leave my A451 quadrant at any time without disrupting what's going on in adjacent quadrants.

36. Students entering or departing other quadrants in classroom 23 disturb my concentration.

37. During cold weather, I feel comfortable in my A451 quadrant.

38. Leave Blank.

39. There is an adequate amount of furniture in my A451 quadrant to support instruction.

40. Leave Blank.

41. When I enter or leave my A451 quadrant, I disturb the activities of students in adjacent quadrants.

42. Electrical outlets in my A451 quadrant are located where needed to power audiovisual equipment during instruction.

SURVEY CONTROL NUMBER: 9136-002

Please write your response to question 43 in the space remaining on this page. Use the back, if needed.

43. What can the Command and General Staff College do to make the physical environment in your A451 quadrant more conducive to learning?

APPENDIX VI

Monthly temperature and relative humidity readings for classrooms 21 and 23 from October 1990 to March 1991.

NOTE: Temperature readings are in degrees Fahrenheit. I listed both the dry and wet bulb readings for each measurement that I made with a sling cyclometer. I calculated the corresponding relative humidity from an analog scale which accompanied this cyclometer.

The start time indicates when I began measuring the temperature in the first quadrant of each classroom. The stop time indicates when I had completed temperature measurements in the last quadrant of each classroom.

When I scheduled my temperature measurements, I was limited to dates and times when both classrooms were free of classes. Hence, dates and times varied among the monthly readings. The cooling season was still in effect during the October measurement. For the remaining measurement dates, the heating season was in effect.

In classroom 23 I also recorded the thermostat setting at the time of my measurement. Conventional CGSOC classrooms do not have adjustable thermostats; therefore, I listed 'not applicable' (N/A) under the thermostat setting for classroom 21.

Finally, I measured the outdoor temperature and relative humidity, and I recorded the weather on each day that I obtained measurements in classrooms 21 and 23. The thermometers on the cyclometer were not graduated lower than thirty degrees Fahrenheit. Therefore, I obtained the outdoor temperature and humidity readings from television weather reports on 8 February 1991 and 7 March 1991.

TEMPERATURE/HUMIDITY READINGS: 2 OCTOBER 1990

CLASSROOM 21

START TIME: 1215 HOURS STOP TIME: 1225 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	74/63	54%	N/A
QUADRANT B	73/63	57%	N/A
QUADRANT C	75/64	54%	N/A
QUADRANT D	75/64	54%	N/A

CLASSROOM 23

START TIME: 1156 HOURS STOP TIME: 1213 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	71/62	60%	86
QUADRANT B	71/62	60%	68
QUADRANT C	71/61	56%	66
QUADRANT D	70/61	60%	73

OUTDOORS

TIME: 1341 HOURS WEATHER: PARTLY CLOUDY/WINDY

TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY
78/66	52%

TEMPERATURE/HUMIDITY READINGS: 2 NOVEMBER 1990

CLASSROOM 21

START TIME: 1300 HOURS STOP TIME: 1310 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	77/33	45%	N/A
QUADRANT B	76/63	48%	N/A
QUADRANT C	77/63	45%	N/A
QUADRANT D	77/63	45%	N/A

CLASSROOM 23

START TIME: 1245 HOURS STOP TIME: 1255 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	82/65	39%	59
QUADRANT B	85/62	25%	59
QUADRANT C	85/66	35%	56
QUADRANT D	83/66	40%	56

OUTDOORS

TIME: 1313 HOURS WEATHER: PARTLY CLOUDY

TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY
71/60	52%

TEMPERATURE/HUMIDITY READINGS: 6 DECEMBER 1990

CLASSROOM 21

START TIME: 1305 HOURS STOP TIME: 1320 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	76/57	28%	N/A
QUADRANT B	76/57	28%	N/A
QUADRANT C	76/57	28%	N/A
QUADRANT D	75/57	30%	N/A

CLASSROOM 23

START TIME: 1254 HOURS STOP TIME: 1303 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	73/52	21%	77
QUADRANT B	73/52	21%	68
QUADRANT C	72/54	29%	73
QUADRANT D	72/52	24%	57

OUTDOORS

TIME: 1330 HOURS WEATHER: PARTLY CLOUDY/WINDY

TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY
44/35	36%

TEMPERATURE/HUMIDITY READINGS: 17 JANUARY 1991

CLASSROOM 21

START TIME: 0730 HOURS STOP TIME: 0740 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	74/53	22%	N/A
QUADRANT B	74/54	24%	N/A
QUADRANT C	75/54	22%	N/A
QUADRANT D	75/54	22%	N/A

CLASSROOM 23

START TIME: 0720 HOURS STOP TIME: 0730 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	68/50	26%	66
QUADRANT B	66/49	24%	59
QUADRANT C	65/49	28%	85
QUADRANT D	66/49	24%	73

OUTDOORS

TIME: 0745 HOURS WEATHER: CLEAR/SNOW ON GROUND

TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY
32/30	78%

TEMPERATURE/HUMIDITY READINGS: 8 FEBRUARY 1991

CLASSROOM 21

START TIME: 0727 HOURS   STOP TIME: 0736 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	73/54	22%	N/A
QUADRANT B	73/53	24%	N/A
QUADRANT C	73/54	22%	N/A
QUADRANT D	73/54	22%	N/A

CLASSROOM 23

START TIME: 0710 HOURS   STOP TIME: 0725 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	75/54	22%	59
QUADRANT B	75/54	22%	68
QUADRANT C	73/54	26%	65
QUADRANT D	75/54	22%	60

OUTDOORS

TIME: 0740 HOURS   WEATHER: PARTLY CLOUDY

TEMPERATURE (DRY)	RELATIVE HUMIDITY
25	78%

TEMPERATURE/HUMIDITY READINGS: 7 MARCH 1991

CLASSROOM 21

START TIME: 0736 HOURS STOP TIME: 0747 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	75/53	20%	N/A
QUADRANT B	75/53	20%	N/A
QUADRANT C	75/53	20%	N/A
QUADRANT D	75/53	20%	N/A

CLASSROOM 23

START TIME: 0725 HOURS STOP TIME: 0735 HOURS

	TEMPERATURE (DRY/WET)	RELATIVE HUMIDITY	THERMOSTAT SETTING
QUADRANT A	78/55	20%	76
QUADRANT B	76/53	18%	68
QUADRANT C	73/53	24%	56
QUADRANT D	75/53	20%	76

OUTDOORS

TIME: [illegible] 53 HOURS WEATHER: CLEAR/SUNNY

TEMPERATURE (DRY)	RELATIVE HUMIDITY
26	75%

APPENDIX VII

Summary of student responses to the forty survey statements. I organized the statements into tables using two criteria. First, I grouped statements by the applicable aspect of the CGSOC classroom interior design: climate control, lighting, acoustics, furniture, access/exit, support equipment, space, or flexibility. Within each aspect, I further arranged statements to display responses from both surveys (groups A, B, and C) as well as responses from the term I survey only (groups A and B).

For the sake of simplicity, I displayed the "Strongly Agree" and "Agree" responses for each statement as "Agree" responses. In like manner, I displayed each statement's "Strongly Disagree" and "Disagree" responses as "Disagree" responses.

The left column lists each statement number followed by a short paraphrase of that statement. Below each paraphrased statement are the simplified response categories: agree, neither agree nor disagree, and disagree.

"Count" columns list the number of students from each group who selected one of the three simplified responses. "Count percent" columns indicate the percentage of students from each group that chose one of these three simplified response categories.

	CLIMATE CONTROL					
	GROUP A		GROUP B		GROUP C	
	Count	Count Percent	Count	Count Percent	Count	Count Percent
3: AIR IS STAGNANT						
AGREE	14	50%	27	64%	50	33%
NEITHER AGREE NOR DISAGREE	5	18%	8	19%	43	28%
DISAGREE	9	32%	7	17%	59	39%
19: WHEN HEAT IS ON AIR TOO DRY						
AGREE	3	11%	20	48%	46	30%
NEITHER AGREE NOR DISAGREE	15	56%	13	31%	73	48%
DISAGREE	9	33%	9	21%	32	21%
37: WHEN COLD OUTSIDE I AM COMFORTABLE						
AGREE	4	15%	5	12%	83	55%
NEITHER AGREE NOR DISAGREE	4	15%	7	17%	48	32%
DISAGREE	19	70%	30	71%	21	14%

	CLIMATE CONTROL			
	GROUP A		GROUP B	
	Count	Count Percent	Count	Count Percent
11: I AM COMFORTABLE IN WARM WEATHER				
AGREE	11	39%	8	19%
NEITHER AGREE NOR DISAGREE	1	4%	8	19%
DISAGREE	16	57%	26	62%
26: AC IS ADEQUATE				
AGREE	10	37%	10	24%
NEITHER AGREE NOR DISAGREE	3	11%	10	24%
DISAGREE	14	52%	22	52%
32: WHEN HUMID OUTSIDE TOO HUMID INSIDE				
AGREE	9	33%	15	36%
NEITHER AGREE NOR DISAGREE	10	37%	14	33%
DISAGREE	8	30%	13	31%

	LIGHTING					
	GROUP A		GROUP B		GROUP C	
	Count	Count Percent	Count	Count Percent	Count	Count Percent
4: ENOUGH LIGHT TO READ TEXTS						
AGREE	22	79%	41	98%	141	93%
NEITHER AGREE NOR DISAGREE	1	4%	1	2%	5	3%
DISAGREE	5	18%			6	4%
12: WINDOW LIGHT INTERFERES WITH A-V						
AGREE	4	14%			3	2%
NEITHER AGREE NOR DISAGREE	10	36%	15	36%	62	41%
DISAGREE	14	50%	27	64%	87	57%
20: WINDOW LIGHT CREATES GLARE ON BOARDS						
AGREE	2	7%			2	1%
NEITHER AGREE NOR DISAGREE	11	41%	16	38%	64	42%
DISAGREE	14	52%	26	62%	85	56%
27: LIGHT CAN BE DIMMED TO SUPPORT AV						
AGREE	21	78%	42	100%	98	65%
NEITHER AGREE NOR DISAGREE	2	7%			48	32%
DISAGREE	4	15%			4	3%
34: LIGHT PERMITS VIEWING BOARDS						
AGREE	22	81%	41	98%	131	87%
NEITHER AGREE NOR DISAGREE	3	11%	1	2%	16	11%
DISAGREE	2	7%			4	3%

	ACOUSTICS					
	GROUP A		GROUP B		GROUP C	
	Count	Count Percent	Count	Count Percent	Count	Count Percent
5: CAN HEAR TV						
AGREE	25	89%	39	93%	135	89%
NEITHER AGREE NOR DISAGREE	1	4%			8	5%
DISAGREE	2	7%	3	7%	8	5%
13: ADJ GP NOISE AFFECTS CONCENTRATION						
AGREE	23	82%	6	14%	14	9%
NEITHER AGREE NOR DISAGREE	4	14%	7	17%	24	16%
DISAGREE	1	4%	29	69%	111	74%
21: CAN HEAR ADJACENT GROUPS						
AGREE	27	100%	14	33%	38	25%
NEITHER AGREE NOR DISAGREE			8	19%	17	11%
DISAGREE			20	48%	97	64%
24: PARTITIONS CREATE DISTURB FREE SPACE						
AGREE			38	90%	103	68%
NEITHER AGREE NOR DISAGREE	2	7%	1	2%	35	23%
DISAGREE	25	93%	3	7%	14	9%
28: CAN HEAR INSTRUCTOR FROM ANYWHERE						
AGREE	21	78%	41	98%	141	94%
NEITHER AGREE NOR DISAGREE					9	6%
DISAGREE	6	22%	1	2%		

	ACOUSTICS			
	GROUP A		GROUP B	
	Count	Count Percent	Count	Count Percent
6: TABLE GROUP NOISE PREVENTS CONCENTRATION				
AGREE	17	61%	12	29%
NEITHER AGREE NOR DISAGREE	6	21%	9	21%
DISAGREE	5	18%	21	50%

	ACCESS/EXIT					
	GROUP A		GROUP B		GROUP C	
	Count	Count Percent	Count	Count Percent	Count	Count Percent
16: OTHERS ENTER-EXIT INTERRUPTS GP ACTIVITIES						
AGREE	22	81%			3	2%
NEITHER AGREE NOR DISAGREE	3	11%	2	5%	8	5%
DISAGREE	2	7%	38	95%	140	93%
35: CAN ENTER-EXIT AND NOT DISRUPT ADJ GP						
AGREE	16	59%	41	98%	140	92%
NEITHER AGREE NOR DISAGREE	4	15%			6	4%
DISAGREE	7	26%	1	2%	6	4%
36: OTHERS ENTER-EXIT DISTURB CONCENTRATION						
AGREE	23	85%	1	2%	5	3%
NEITHER AGREE NOR DISAGREE	2	7%	2	5%	10	7%
DISAGREE	2	7%	39	93%	137	90%
41: MY ENTER-EXIT DISTURBS ADJ GROUPS						
AGREE	8	30%			10	7%
NEITHER AGREE NOR DISAGREE	4	15%			21	14%
DISAGREE	15	56%	42	100%	118	79%

	FURNITURE					
	GROUP A		GROUP B		GROUP C	
	Count	Count Percent	Count	Count Percent	Count	Count Percent
7: DESK SPACE IS ADEQUATE						
AGREE	8	29%	26	62%	106	70%
NEITHER AGREE NOR DISAGREE	1	4%	5	12%	13	9%
DISAGREE	19	68%	11	26%	32	21%
14: CHAIRS ARE COMFORTABLE						
AGREE	20	71%	35	83%	120	79%
NEITHER AGREE NOR DISAGREE	5	18%	3	7%	8	5%
DISAGREE	3	11%	4	10%	24	16%
22: TOO MUCH FURNITURE						
AGREE	15	56%	10	24%	15	10%
NEITHER AGREE NOR DISAGREE	5	19%	16	38%	47	31%
DISAGREE	7	26%	16	38%	90	59%
39: AMOUNT OF FURNITURE ADEQUATE						
AGREE	17	63%	30	71%	110	73%
NEITHER AGREE NOR DISAGREE	7	26%	10	24%	35	23%
DISAGREE	3	11%	2	5%	5	3%

	SUPPORT EQUIPMENT					
	GROUP A		GROUP B		GROUP C	
	Count	Count Percent	Count	Count Percent	Count	Count Percent
8: PROJ SCREEN INTERFERES WITH BOARDS						
AGREE	13	46%	25	60%	68	45%
NEITHER AGREE NOR DISAGREE	2	7%	4	10%	42	28%
DISAGREE	13	46%	13	31%	40	27%
18: CAN VIEW TV FROM SEAT						
AGREE	18	67%	38	90%	135	89%
NEITHER AGREE NOR DISAGREE	5	19%	1	2%	5	3%
DISAGREE	4	15%	3	7%	12	8%
23: SUFFICIENT CHALK OR MARKER BOARDS						
AGREE	14	52%	29	69%	91	60%
NEITHER AGREE NOR DISAGREE	3	11%	6	14%	38	25%
DISAGREE	10	37%	7	17%	23	15%
33: ENOUGH ELECTRICAL OUTLETS						
AGREE	8	30%	41	98%	76	50%
NEITHER AGREE NOR DISAGREE	2	7%			73	48%
DISAGREE	17	63%	1	2%	3	2%
42: ELECTRICAL OUTLETS WELL LOCATED						
AGREE	9	33%	38	97%	74	50%
NEITHER AGREE NOR DISAGREE	5	19%			69	47%
DISAGREE	13	48%	1	3%	5	3%

	SUPPORT EQUIPMENT			
	GROUP A		GROUP B	
	Count	Count Percent	Count	Count Percent
15: COMPUTER LOCATION SUPPORTS INSTRUCTION				
AGREE	10	37%	18	43%
NEITHER AGREE NOR DISAGREE	6	22%	4	10%
DISAGREE	11	41%	20	48%
29: TACK BOARDS ARE SUFFICIENT				
AGREE	14	52%	31	74%
NEITHER AGREE NOR DISAGREE	2	7%	2	5%
DISAGREE	11	41%	9	21%
38: EASY TO USE TACK BOARDS				
AGREE	16	59%	14	33%
NEITHER AGREE NOR DISAGREE	4	15%	3	7%
DISAGREE	7	26%	25	60%

	SPACE					
	GROUP A		GROUP B		GROUP C	
	Count	Count Percent	Count	Count Percent	Count	Count Percent
10: PHYSICAL SURROUNDINGS ARE CONFINING						
AGREE	17	61%	11	26%	39	26%
NEITHER AGREE NOR DISAGREE	1	4%	13	31%	32	21%
DISAGREE	10	36%	18	43%	81	53%
31: INDIVIDUAL SPACE IS SUFFICIENT						
AGREE	8	30%	23	55%	96	64%
NEITHER AGREE NOR DISAGREE	3	11%	4	10%	18	12%
DISAGREE	16	59%	15	36%	35	23%

	SPACE			
	GROUP A		GROUP B	
	Count	Count Percent	Count	Count Percent
25: ENOUGH SPACE TO STORE REFERENCES				
AGREE	7	26%	20	48%
NEITHER AGREE NOR DISAGREE			5	12%
DISAGREE	20	74%	17	40%
40: STORAGE SPACE ADEQUATE				
AGREE	7	26%	19	45%
NEITHER AGREE NOR DISAGREE	3	11%	4	10%
DISAGREE	17	63%	19	45%

	FLEXIBILITY			
	GROUP A		GROUP B	
	Count	Count Percent	Count	Count Percent
9: FURNITURE EASILY REARRANGED				
AGREE	15	54%	32	76%
NEITHER AGREE NOR DISAGREE	1	4%	5	12%
DISAGREE	12	43%	5	12%
17: GROUP MEMBERS CAN EASILY CLOSE PARTITIONS				
AGREE	8	30%	19	45%
NEITHER AGREE NOR DISAGREE	2	7%	9	21%
DISAGREE	17	63%	14	33%
30: STUDENTS RAPIDLY OPEN PARTITIONS				
AGREE	18	67%	19	45%
NEITHER AGREE NOR DISAGREE	7	26%	7	17%
DISAGREE	2	7%	16	38%

APPENDIX VIII

Observations I made in my year as a CGSOC student assigned to the model classroom. Although my observations do not directly relate to the effect of classroom interior design on the quality of the physical learning environment, I feel that they should be included in this study for future reference when validating the model classroom design.

The following observations relate problems in the mechanics of operating within the model classroom.

Projection Screen. The model classroom's projection screens were unlike those of the conventional CGSOC classrooms in method of deployment. Screens in conventional classrooms required instructors or students to jerk or tug the screens to lock them in place. Conversely, a model classroom screen merely needed to be held in place for a few seconds to allow the screen's locking mechanism to engage. If students or instructors tugged or jerked these screens, they simply would not lock in place.

However, instructors generally knew of no way to lock screens in place other than what they used for conventional classroom screens. Consequently, College faculty and students from conventional classrooms often became frustrated while trying to deploy model classroom screens. I know of one instructor who pulled the screen off the ceiling in his attempts to lock it in place. Further, I observed another instructor literally "attack" a screen in the model classroom as he tried to lock it in place.

A second problem associated with the model classroom projection screens was deployment length. By design, these screens were to be deployed no longer than six feet. However, instructors and students routinely

deployed these screens up to nine feet in length. Although damage to the screens was not immediately noticeable, the prolonged overextension of these screens will most certainly result in their early obsolescence.

To correct both these problems, I recommend that the College's Directorate of Support Activities permanently mount instructions for proper projection screen use near each screen in the model classroom.

Audiovisual system. The model classroom's audiovisual system was different from that of any conventional CGSOC classroom. Specifically, to operate either of the video cassette players on the classroom-wide system required knowledge of which switch to engage in quadrant A's audiovisual cabinet. On numerous occasions, I observed instructors become frustrated during class time because they didn't know how to operate the classsroom-wide audiovisual system. Prior to class, they had failed to ask classroom services personnel how to use the system. Accordingly, I recommend that the College's Directorate of Support Activities permanently mount instructions for the operation of the model classroom's audiovisual system in the each quadrant's audiovisual cabinet.

Operable walls. The operation of the model classroom's operable walls was unlike that of the partitions in conventional CGSOC classrooms. In

particular, each of two wall sections formed the base of a portion of the wall. Consequently, these wall sections locked in place. Subsequently, this lock had to be disengaged to again move or redeploy these wall sections. I observed students on several occasions trying to move these base wall sections with the locking mechanisms still engaged. Should this practice continue, damage will result in the carpet squares on the floor under the wall sections.

The deployment of the operable wall sections also required attention to detail. Prior to locking the base wall sections in place, they first had to be plumb. If not, the portion of the wall for which they formed a base was not plumb. In turn, wall sections did not fit together properly. On several occasions, I observed one-quarter inch gaps between wall sections of a deployed wall. These gaps were the result of the base wall section not being plumb when initially locked in place.

Similar to my previous two recommendations, the College's Directorate of Support Activities should permanently mount instructions for the proper deployment and redeployment of the model classroom's operable walls on both sides of the two base wall sections (those that lock in place) and on the door which encloses the east-west wall sections.

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